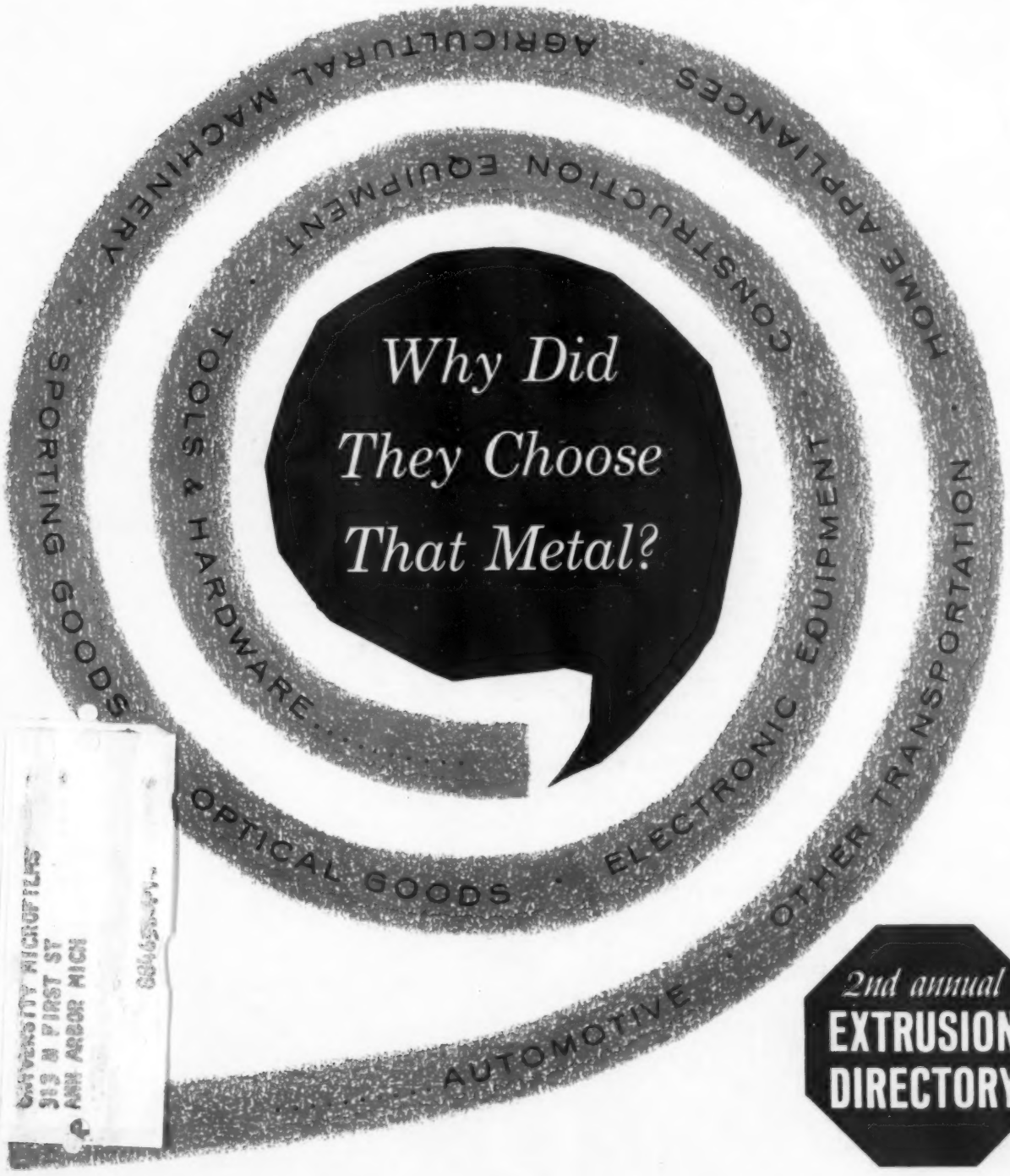
OCTOBER 1961

Precision Metal Molding

INCLUDING DIE CASTINGS MAGAZINE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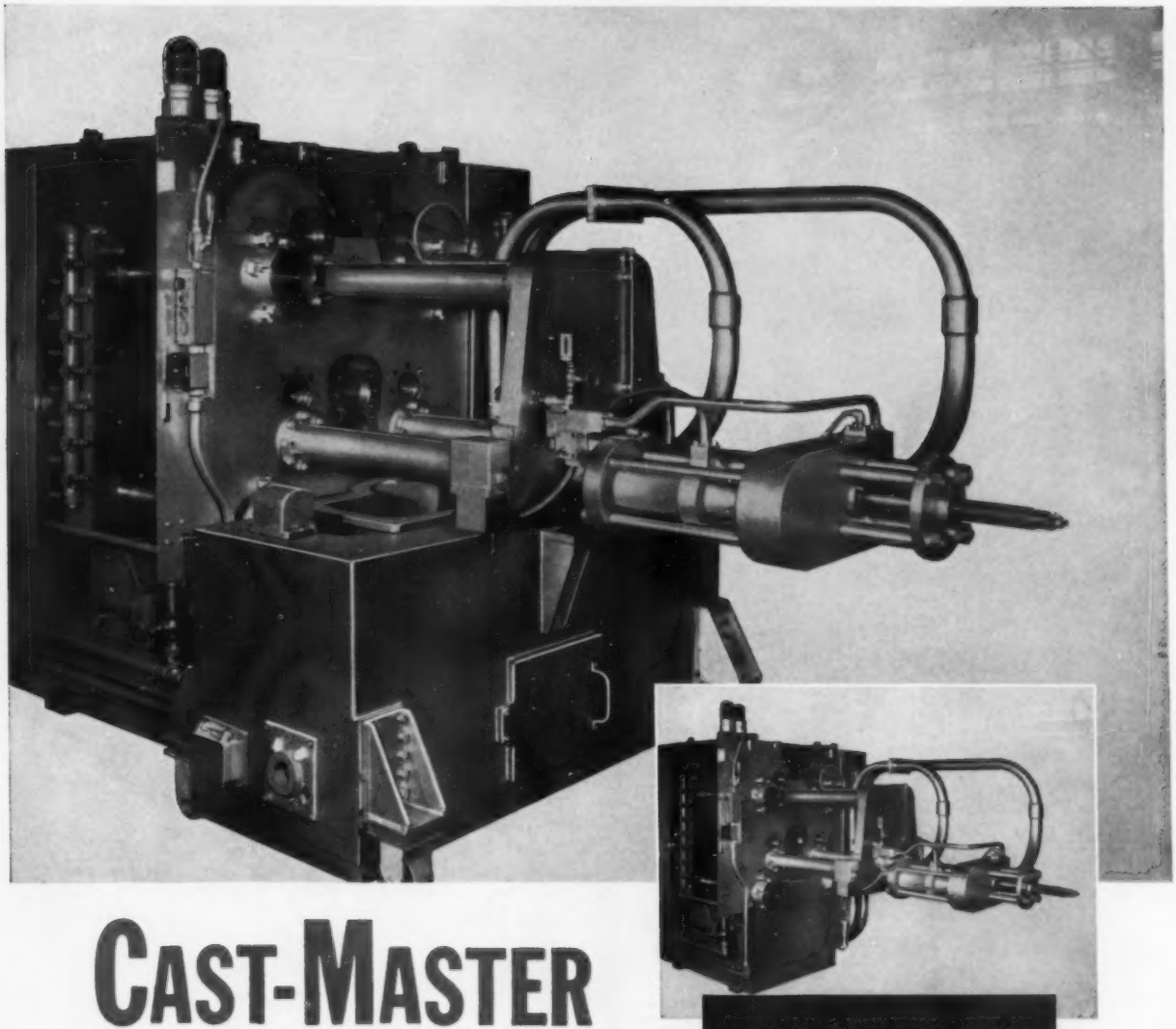

CAST-MASTER

builds what the die caster needs

Compact efficiency made possible with redesigned injection end is illustrated. Injection and intensifier cylinders are side by side; high pressure piping is shown to rear of cylinders. Furnace rolls under injection assembly—out of the way and close to work station.

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Backed by a program that is "customer-controlled", Cast-Master consistently strives to improve its machines. The latest in a long list of modifications, through the years, are illustrated. They include:

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- **Cast-Master shot intensifier system operates without valves. Instant intensification of injection pressure *improves casting quality—gives smoother finishes, decreases porosity.***
- **Slow shot principle delays high speed injection plunger till after plunger passes metal pouring opening. (Eliminates splash.)**
- **Injection assembly is infinitely adjustable from minimum to maximum injection speed.**

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PMM October, 1961: Volume 19 Number 10

Precision Metal Molding

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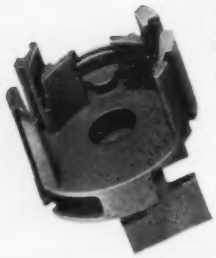

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PMM letters

the readers' forum

W. N. Brammer, Vice President of Marketing for Precision Castings Company, passed the following letters on to us with the thought that PMM's readers might enjoy them.

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July 31, 1961

Mr. Hydroway Scales
31302 Stephenson Highway
Royal Oak, Michigan

Dear Mr. Scales:

Today's purchasing target is to "get what you pay for."

The attached article reprint could [illegible]
It's an authoritative [illegible] are available to you.
[illegible] Precision Castings field engineer, or call
[illegible] here in Cleveland. Your request will receive our most prompt attention.

Yours very truly,

PRECISION CASTINGS COMPANY

William N. Brammer

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PLANT LOCATION
31302 STEPHENSON HIGHWAY
MADISON HEIGHTS, MICH.

August 9, 1961

Mr. Precision Castings Company
12600 Berea Road
Cleveland 11, Ohio

Dear Mr. Company:

This is with reference to your letter of July 31st to our Mr. Scales.

Please be advised that Mr. Scales is no longer with our company and any further correspondence should be addressed to his older brother, Mr. Hydroway Scales, INC.

Please revise your mailing list accordingly.

Thank you.

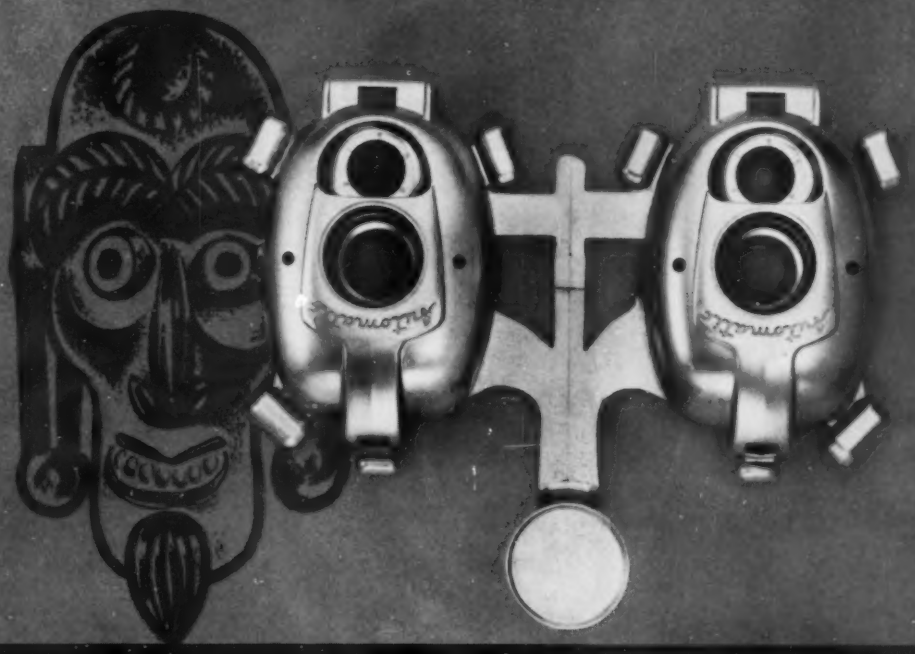
Very truly yours,

I. M. Goodwill

I. M. Goodwill,
Public Relations Dept.

A further exchange of letters showed that I. M. Goodwill was the pseudonym for Thomas W. Wise, Hydroway's office manager. Wise and Brammer agreed that an honest chuckle such as this comes rarely.

unmasking the myth of clamping tonnage...



ELECTROLUX CASTINGS PROVE THAT
LESTER'S CERTIFIED CLAMP
IS ALL YOU NEED.....

The theory in figuring the clamp required to hold an aluminum die casting is to multiply the plunger tip pressure by the projected area of the shot and then divide by 2000—that gives you the theoretical load in tons. Take the part shown above. With 105 sq. ins. of projected area and plunger tip pressure @ 11,000 p.s.i., the theoretical clamp required would be close to 600 tons. And some die casters would recommend more, perhaps 800 tons, to avoid "normal" blowback. That's theory. *The fact is, these parts run on a 400 ton Lester!*

How Come? Well, one point is that the molten metal is never an entirely hydraulic fluid, as theory supposes. But even more important is the fact that the Lester one-piece cast steel frame delivers every pound of its CERTIFIED locking tonnage to clamp the die evenly and solidly for the life of the machine. No blowback, no misalignment, no sagging, no adjustments.

The name "Electrolux" is known to millions of homemakers as an outstanding vacuum cleaner. The Electrolux Corporation of Old Greenwich, Connecticut, has built this recognition by producing and using high-quality precision made parts.

About two years ago, after a year of investigation, Electrolux decided to start manufacturing its own aluminum die castings. After inspecting a number of makes of die casting machines in various plants, they selected and purchased several Lester die casting machines. The new department has been producing precision castings from the start with good results from their Lester machines.

If you are looking for modern die casting equipment that delivers its rated clamp and capacity, to produce dense, flash-free parts—write for specifications on Lester Die Casting Machines.

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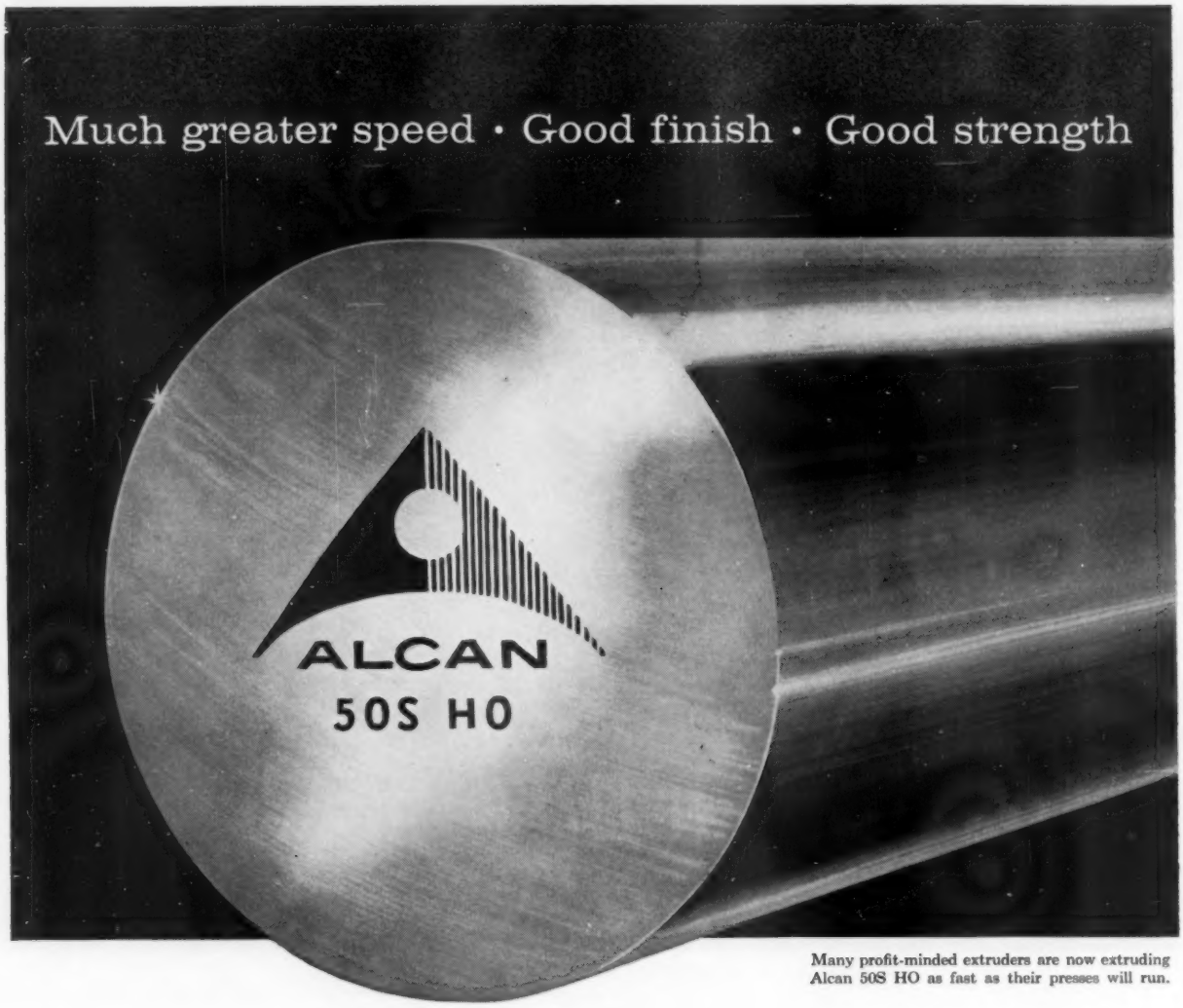

Many profit-minded extruders are now extruding Alcan 50S HO as fast as their presses will run.

Here in one aluminum ingot...

much greater extrusion speed... plus good finish and strength

When you run Alcan 50S HO you get greater production . . . per day and per machine-hour . . . while still maintaining good mechanical properties and finish.

That sums up the experience of many fabricators now using this much-improved version of the long-time favorite Alcan 50S. They're unanimously enthused about its increased press speed . . . *up to maximum press capacity.*

Because of the all-around performance of Alcan 50S HO, there is no longer any necessity for stocking a large variety of ingot products. This one ingot takes care of the majority of product runs. Alcan 50S HO Ingot can reduce your inventory as much as 60%.

Alcan of course supplies other types of extrusion ingot to meet special job requirements.

Run 50S HO on your own equipment . . . and clock your production on the run-out table.

For further information on Alcan 50S HO, write or phone your nearest Aluminium Limited Sales Office.

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ALCAN

Which of these parts should be investment cast?

. . . *All* the parts except the milling machine collet at the top right—which is a "natural" for conventional lathe work. Even the helical impeller the men are examining is best made as an investment casting—the helix is undercut in such a way that no cutting tool could reach inside to remove the metal.

"Naturals" for investment casting are usually parts that are too intricate to be made economically by any other process, or involve alloys or quantities that make them impractical to produce by other methods. In other words, when it looks as if you might have to sacrifice a design because its complexity makes the cost prohibitive, or forego a preferred alloy because it is difficult to machine, then it's time to take a long, hard look at investment casting.

But . . . it's not always as easy as it sounds to spot the parts that are "made" for investment casting. That's where the Arwood sales engineer comes in. He knows Arwood expects him to show a customer how to get the most from the process. To help keep your cost down he may have to suggest a filleted radius here . . . or a tolerance opened up there. Then too, on occasion he may readily have to admit the part should not be investment cast at all. However, he also knows that if you just can't have the part made any other way, Arwood will go all the way down the line to have it investment cast for you.

Our five plants cast every castable metal and alloy, including magnesium and superalloys. Each has its own research, tooling, quality control and production facilities. In short, if it can be investment cast, we can investment cast it.

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Write us for a complimentary copy of our 44-page manual, "Practical Guide to Investment Casting." Among other sections it includes practical tips on designing for investment casting, as well as analyses and physical and mechanical properties of all the metals and alloys cast by Arwood.

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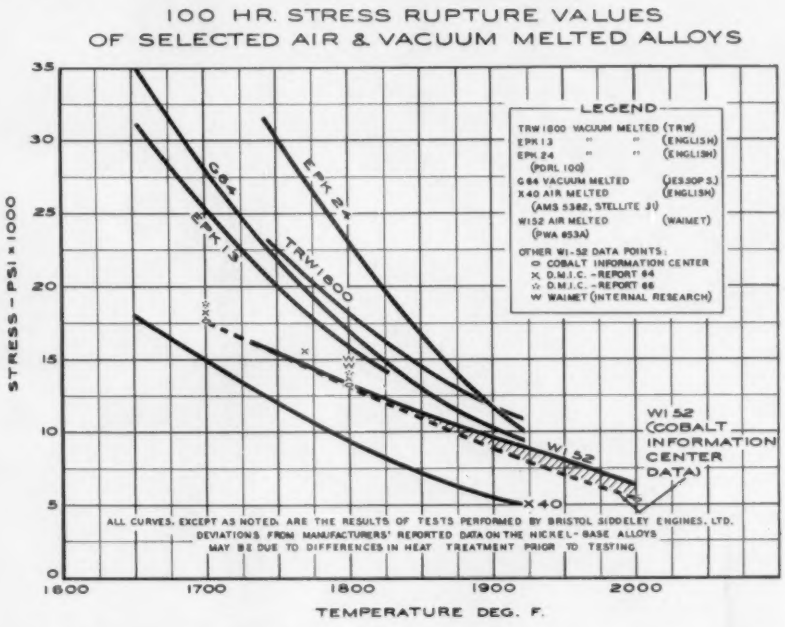
PMM

casting about *technical news of applications & processes involving precision metal molding*

Air melted alloy has high stress rupture properties

Air melted cobalt base WI-52 superalloy has high temperature stress rupture properties nearly as good as expensive vacuum melted nickel base superalloys. This was revealed by data released by Bristol Siddeley Engines Ltd., British aircraft manufacturers.

Curves developed by the firm show a small difference in stress rupture properties between the air and vacuum melted alloys in the 1800° to 2000°F temperature range. Because the air melted alloy costs less to melt and cast than vacuum melted alloys, designers may give it increased consideration for investment cast parts requiring high stress rupture properties at high temperatures.


100 HR. STRESS RUPTURE VALUES
OF SELECTED AIR & VACUUM MELTED ALLOYS
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TEMPERATURE DEG. F.
LEGEND
TRW 1800 VACUUM MELTED (TRW)
EPK 13 " " (ENGLISH)
EPK 24 " " (ENGLISH)
(PDRL 100)
G 64 VACUUM MELTED (JESSOP S.)
X 40 AIR MELTED (ENGLISH)
(AMS 5382, STELLITE 31)
WI 52 AIR MELTED (WAIMET)
(PWA 653A)
OTHER WI-52 DATA POINTS:
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✕ D.M.I.C. - REPORT 64
☆ D.M.I.C. - REPORT 66
W WAIMET (INTERNAL RESEARCH)
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TRW 1800
WI 52
X40
WI 52 (COBALT INFORMATION CENTER DATA)
ALL CURVES, EXCEPT AS NOTED, ARE THE RESULTS OF TESTS PERFORMED BY BRISTOL SIDDELEY ENGINES, LTD.
DEVIATIONS FROM MANUFACTURERS' REPORTED DATA ON THE NICKEL-BASE ALLOYS
MAY BE DUE TO DIFFERENCES IN HEAT TREATMENT PRIOR TO TESTING

According to WaiMet Alloys Co., producers of WI-52, the alloy has excellent castability and foundry characteristics. They say it is easy to control in melting and flows freely, filling investment casting molds without difficulty. Cast parts made from this alloy do not require heat treatments. It is less prone to casting defects and misruns than other comparable alloys. Also, there is little danger of losing chemistry control with this alloy during the casting operation, according to the producer.

The alloys compared in the curves shown above include vacuum melted nickel base alloys TRW-1800 (Thompson, Ramo, Woolridge), EPK-13 (English Alloy), EPK-24 (English Alloy), G-64 (Jessop Steel), cobalt base high-tungsten air melted superalloys X-40 (AMS-5382), and WI-52 (WaiMet Alloys Co.).

WI-52 has the best high temperature properties of the air melted group of superalloys.

Stairway railings made from stainless steel extrusions

The handrails and tubing for a circular staircase at The Brookings Institution Center for Advanced Study in Washington are made from stainless steel extrusions. It is believed that this is the first such application of extruded steel sections.

The extrusions are 100 feet long. They were made from type 304 stainless steel by Allegheny Ludlum Steel Corporation.

The curve in the railings was obtained by heating and bending the extrusions in a jig. Welds were made with stainless steel welding rods using the Heliarc submerged arc (argon gas) process. To complete the finishings, the railings were ground and polished to a satin smooth finish.

The RZ Process utilizes the established and proven advantages of liquidous metallurgy to produce a spherical ferrous powder designed to the critical applications of the powder metallurgy process. Easton RZ powders are available in the following grades:

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RZ 365–M
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RZ 365–S
RZ–200
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RZ–F

Magnetic inspection powders
RZ–MIM
RZR–MIM
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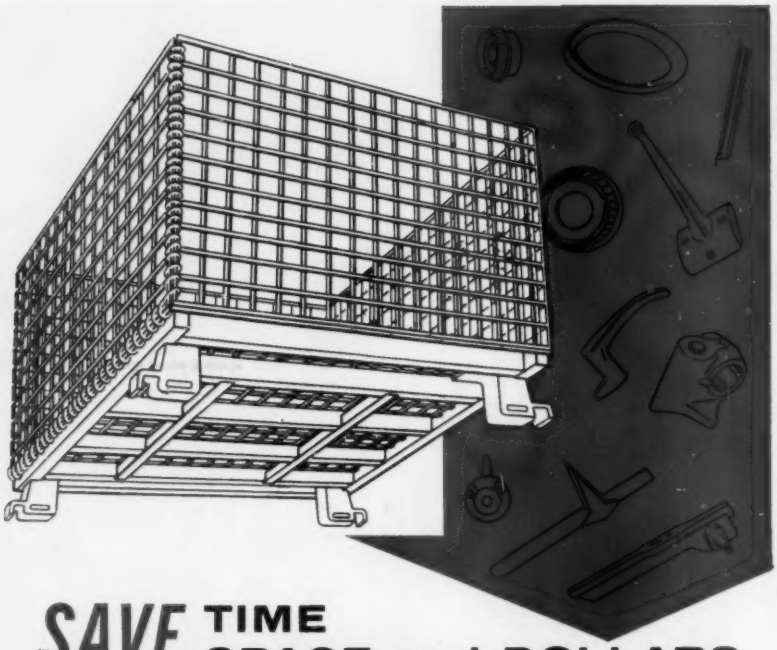

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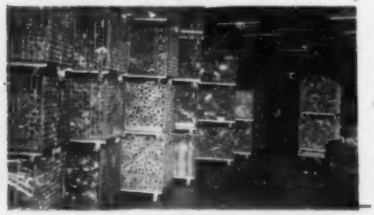

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PMM

book reviews

Fundamental Principles of Powder Metallurgy *W. D. Jones; St. Martin's Press Inc., New York, 1960. 1032 pages. $30.00*

Dr. Jones' first comprehensive book on powder metallurgy appeared in 1937, and as he so aptly states it, "much powder has been sieved" since then. There has been a remarkable expansion in the use of powder metallurgy techniques, and Dr. Jones has compiled this new work to provide a full and broad account of the fundamental, theoretical, and practical principles of the subject.

Besides providing up to date information on the subject, the author tries to present the reader with a proper perspective by showing him both the origins and likely future course of the science.

A valuable feature of the book is material drawing attention to the gaps in current knowledge of the subject. This can help those seeking new subjects for investigation and research.

Presentation is in the form of a text book for science graduates or more mature readers.

Aids to Machine Shop Practice *C. T. Bower; The MacMillan Company, New York, 1961. 208 pages. $4.50*

More than 200 hints, tips, and shortcuts for increasing production or simplifying work in the machine shop is presented in this book. Production and maintenance men, draftsmen, machine operators, and toolmakers may find the suggestions useful. Drawings and photographs show details so that the reader can make up any of the devices described, or modify existing machines and tools as suggested.

more Books on page 16

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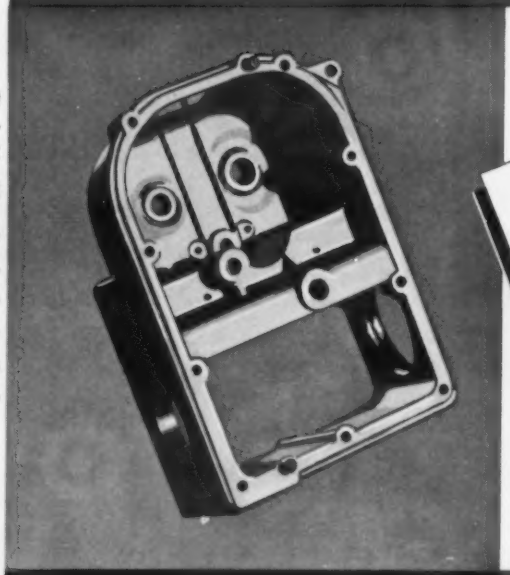
SPECIAL HIGH GRADE ZINC



Dimensional stability and close tolerance make zinc superior for die casting

Dimensional stability is vital in many die cast parts, particularly for easy and consistent mating of complex shapes. ZINC offers the highest dimensional stability of all common die cast metals. ZINC can be cast to remarkably close tolerances, often eliminating entirely the need for machining.

TADANAC Brand Special High Grade Zinc . . . electrolytically refined under carefully controlled conditions, has the overall purity and the low individual impurity content (determined spectrographically) to ensure it is completely satisfactory for die cast alloy manufacture.

TECHNICAL SERVICE
Behind TADANAC Brand metals is a technical service team and a strong research organization ready to assist you to use our zinc to your best advantage.

TADANAC SHG *FOR DIE CAST QUALITY*

COMINCO

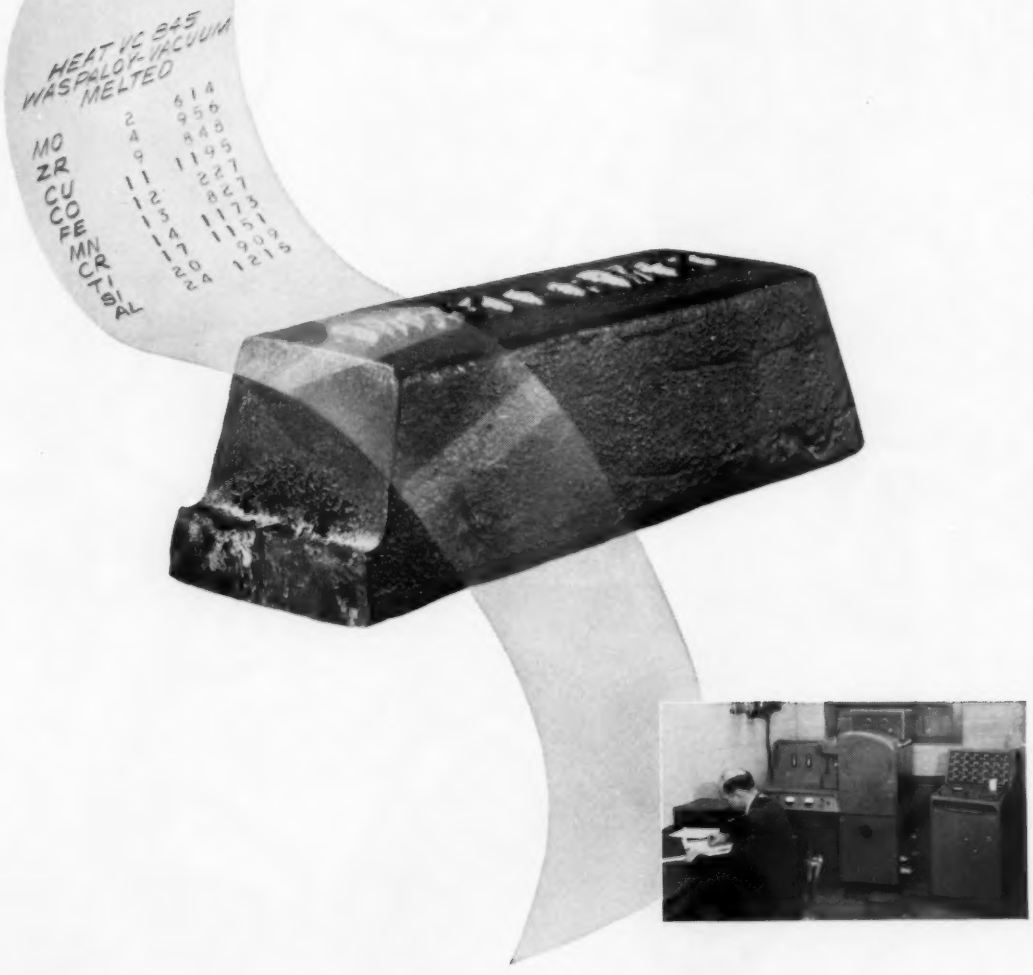
THE CONSOLIDATED MINING AND SMELTING COMPANY OF CANADA LIMITED, MONTREAL

Tadanac Brand Metals are sold in United States by American Metal Climax, Inc., New York, Chicago, Detroit, Los Angeles

Circle No. 28 on Reader Service Card

NEW 15-MINUTE X-RAY OF AN ALLOY MEANS STILL HIGHER QUALITY...

STILL FASTER SERVICE FROM C-M. HERE'S THE RESULT OF A GREAT NEW ADVANCE IN QUALITY CONTROL — A COMPLETE ALLOY ANALYSIS ON PRINTED TAPE OBTAINED WITH THE UNIQUE NEW X-RAY SPECTROGRAPHIC PROCESS. THIS NEW METHOD BENEFITS YOU TWO IMPORTANT WAYS: FIRST, IT MAKES ALLOY ANALYSIS MORE ACCURATE THAN EVER BEFORE . . . WHICH MEANS ADDED CERTAINTY THAT YOUR ALLOYS ADHERE RIGIDLY TO QUALITY SPECIFICATIONS. ALSO, THIS NEW X-RAY PROCESS MAKES THE COMPLETE ANALYSIS IN JUST 15 MINUTES INSTEAD OF 3 DAYS. TOTAL RESULT: STILL HIGHER QUALITY, BETTER SERVICE, FASTER DELIVERY. A POST CARD BRINGS FULL INFORMATION.



ULTRA MET
VACUUM ALLOYS

CANNON-MUSKEGON CORPORATION

METALLURGICAL SPECIALISTS • 2871 LINCOLN STREET • MUSKEGON, MICHIGAN
PRODUCERS OF IRON, NICKEL AND COBALT ALLOYS: SHEET, WIRE, BAR, FORGINGS, INGOTS, SHOT

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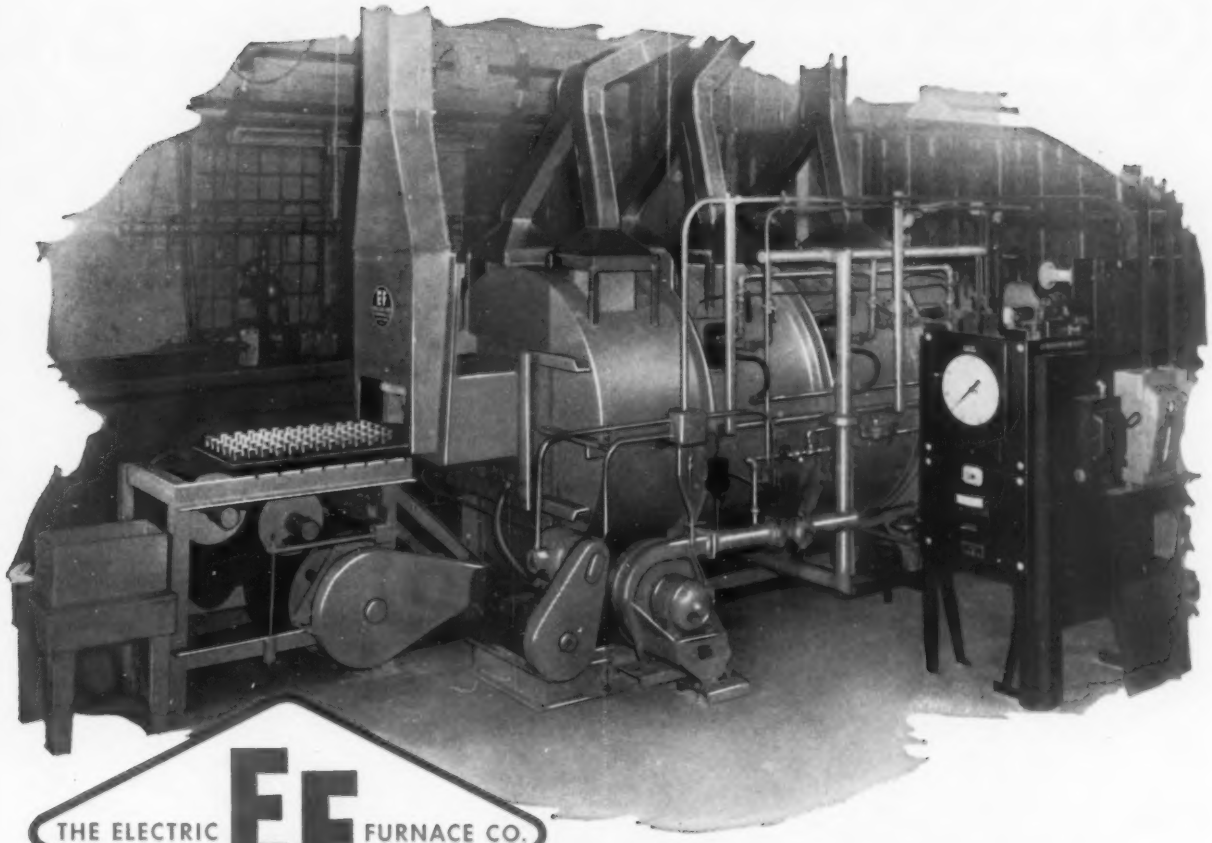


THE ELECTRIC EF FURNACE CO.
GAS • OIL • ELECTRIC

Sintering Furnaces

for processing metal powder products and bonding metal powder to strip

Wide experience in sintering ferrous and non-ferrous pressed metal products of different analysis, shape and size; bonding powder to strip, and other "powdered metal" heat treatments. Installations in daily operation range from small fuel fired or electrically heated wire mesh belt furnaces to high production combination fuel fired and electrically heated roller hearth furnaces more than 100 feet long.

The treatment varies with the powders being processed. The green compacts are sometimes carried through the furnace directly on a wire mesh belt,— but more frequently are loaded on trays, which in turn are moved through the furnace on a wire mesh belt or roller hearth conveyor. Use of a heat resisting alloy muffle tube, or radiant tube heating elements, in fuel fired furnaces, eliminates any contamination of the work with flue products, and permits exact atmosphere control. Outputs to meet *any* production requirement.

A thorough understanding of the problems involved, and careful engineering, assure production of a high quality product, of unvarying uniformity, that finds highest market acceptance.

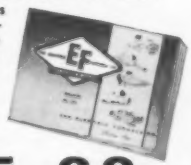
Ask us also about our wide experience in designing and building furnaces for annealing, normalizing, hardening, carburizing, nitriding, carbon restoration, galvanizing, coating, brazing, billet heating, malleablizing and other heat treatments.

For any ferrous or non-ferrous furnace heat treating project you will find "It pays to call the EF heat treating engineers". Let us work with *you* on *your* next project.

SEND FOR BULLETIN NO. 591

Twenty pages. It illustrates and describes the many different types of furnaces we build, and the applications in which each is used.

Write for your copy TODAY!



THE ELECTRIC FURNACE CO.

Gas-fired, Oil-fired and Electric Furnaces for Heat Treating any Product, Using any Process, any Hourly Output.

550 West Wilson Street *Salem - Ohio*

Branch Offices in Detroit, Mich., Santa Ana, Calif., and Cheshire, Conn. Canadian Associates, Canefco Limited, Toronto 13, Ontario

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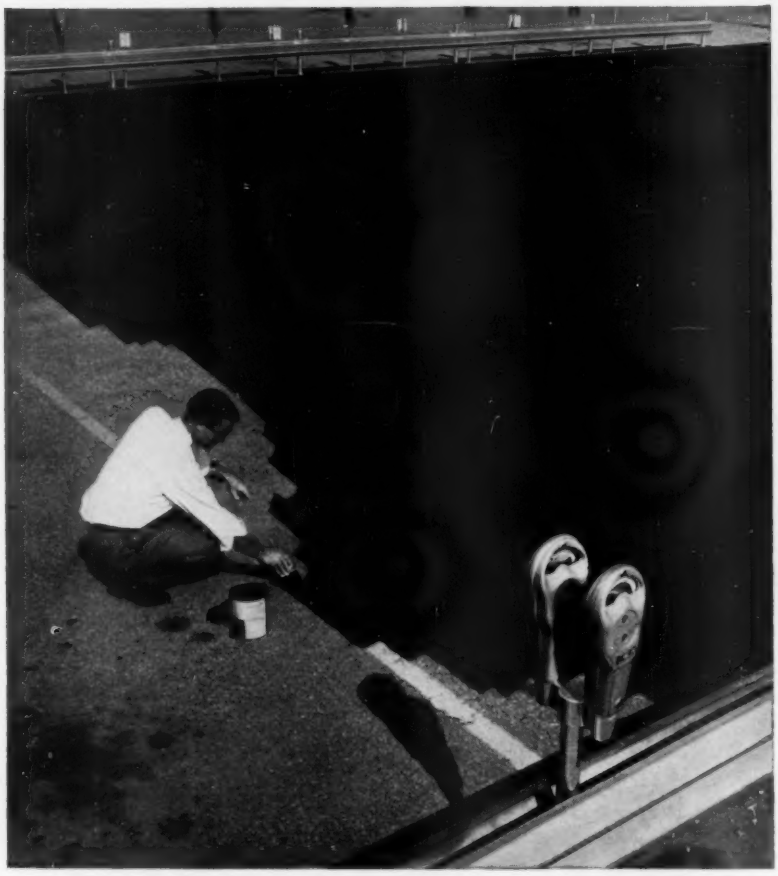
DISPERSION QUALITY IS ACHESON



Paint a parking lot with colloidal graphite?

Maybe not practical . . . but very possible. A pound of colloidal graphite contained in 'Aquadag'® is capable of coating a surface area of over half an acre! Under similar circumstances 325 mesh graphite will hardly cover the area of a two car garage. Increased film coverage enables Acheson to supply both quality as well as greater economy in its dispersions. IT'S A MATTER OF COST PER AREA OR APPLICATION RATHER THAN COST PER POUND! Engineering note: Acheson dispersions provide a thinner film which does not affect tolerances . . . a distinct advantage in many industrial applications.

To learn more about the unique advantages of Acheson dispersions as they apply to your lubricating problems, write Dept. PMM101.

ACHESON—First name in solid lubricants for fifty-three years.

ACHESON Colloids Company

PORT HURON, MICHIGAN

A division of Acheson Industries, Inc.

Sales offices in principal cities.

Also Acheson Industries (Europe) Ltd. and affiliates, London, England

Circle No. **2** on Reader Service Card

book reviews

Continued from page 12

ASM Review of Metal Literature, 1960 *Edited by Marjorie R. Hyslop; American Society for Metals, Novelty, Ohio, 1960. 1342 pages. $25,00*

This review contains over 11,000 annotations on metal literature, articles, technical papers, reports, and documents appearing in engineering, scientific, and industrial journals, and books published in 1960. In most cases the brief abstracts are intended only to indicate the nature and scope of the article rather than serve as a substitute for reading.

Bibliography on Powder Metallurgy in Nuclear Engineering (1956-1960) *Henry H. Hausner and Helen C. Friedemann; Metallwerk Plansee Aktiengesellschaft. Reutte, Tyroll, 1961. 119 pages. $2.00*

This bibliography lists 643 references from literature published between 1956 and 1960 dealing with the application of powder metallurgy in nuclear engineering. The references are arranged alphabetically according to authors, but a subject index permits selection of materials on specific topics. References are taken from report, magazine, and book literature from the major industrial nations, including the Soviet Union.

High-Strength Steels for the Missile Industry *Edited by H. T. Sumsion; American Society for Metals. Novelty, Ohio, 1961. 276 pages. $12.00.*

This book is primarily a compilation of technical papers covering methods of analysis and tests used to aid in the design of high strength steel components for missiles. Subject matter spans the fields of fabrication techniques, metallurgical tests, stress considerations, and fracture theory.

Circle No. 84 →

Quality... the best economy of all

Another product of Sunoco research . . . a fire-resistant hydraulic fluid

The flame test, above, dramatizes the effectiveness of Sun's new fire-resistant hydraulic fluid. The wick in the conventional fluid burns readily; the wick in Sun's new fluid just can't be lighted.

SUNSAFE, a water-in-oil emulsion, eliminates fire hazards . . . provides increased safety to personnel and equipment. At the same time, operators get the essential performance characteristics of a top-grade hydraulic oil—low rates of wear, long service life, and protection against rust and corrosion.

This combination of *quality* in engineering know-how, and *quality* in product, proves once again that *quality* in any sense is the best economy of all.

For 73 years Sunoco has meant quality right down the line. Today, this quality is found in more than 400 Sunoco industrial products. SUN OIL COMPANY, Phila. 3, Pa., Dept. I-14.
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MAKERS OF FAMOUS CUSTOM-BLENDED BLUE SUNOCO GASOLINES

SUNOCO®

PRINTED IN U.S.A.

Why the DIE CASTER

talks D-M-E STANDARD UNIT DIES to the Die Designer and Die Maker

Changeover time goes down ...Profits on short runs go up!

Die changes on zinc or aluminum castings which normally take 3 to 5 hours are now done in minutes with D-M-E Standard Unit Dies.

D-M-E Replacement Units are fully interchangeable: Quickly and easily they're taken out and replaced in the Unit Holder . . . production is continued immediately!

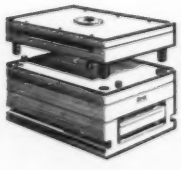
Because several jobs can run on one machine, you increase profits on short run jobs. What's more, you get the quality, the performance and the standardization of replacement parts needed for volume production work.

DIE CASTERS, DESIGNERS AND DIE MAKERS GET MORE FROM D-M-E!

• AVAILABILITY: D-M-E Replacement Units are carried in stock at your local D-M-E Branch for quick delivery. • VARIETY: D-M-E Replacement Units are available in your choice of steel and hardness. • UTILITY: D-M-E has a Standard Unit Die to fit your machine, whether you require rack and pinion or automatic "bumper-type" ejection. • FLEXIBILITY: Complete freedom on three sides of the cavity for core or cooling line placement; six leader pins and bushings for accurate alignment; "quick change" wedge clamps for positive plate positioning. • Start increasing profits on your short-run jobs with D-M-E Standard Unit Dies!

Write for your free copy of *Lower Die Cost Through Standardization.*

61-A-DC



DETROIT MOLD ENGINEERING COMPANY

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Chicago • Hillside, N. J. • Los Angeles • D-M-E- Corp., Cleveland, Dayton
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Injection and Compression Mold Bases • Injection Unit Molds • Cavity Retainer Sets • Mold Plates • Ejector and Core Pins
Ejector Sleeves • Leader Pins and Bushings • Sprue Bushings • Moldmakers' Tools and Supplies

Circle No. **30** on Reader Service Card

just one claim . . .

We'll make your job easier by removing fancy claims, gimmicks and promises from your "listening" schedule when you're looking for a source for the best in die castings.

Our claim:

Precision Castings Company will be your best source for die castings because we supply what you want in terms of "the four points that make the great difference"—QUALITY . . . CAPACITY . . . SERVICE . . . and PRICE.

We can prove it! Call any Precision Castings division, or your nearest Precision field engineer.

PRECISION CASTINGS COMPANY

A DIVISION OF FULTON INDUSTRIES, INC.

FAYETTEVILLE DIVISION
FAYETTEVILLE, N.Y.

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DOLLIN DIVISION
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CLEVELAND DIVISION
CLEVELAND, OHIO

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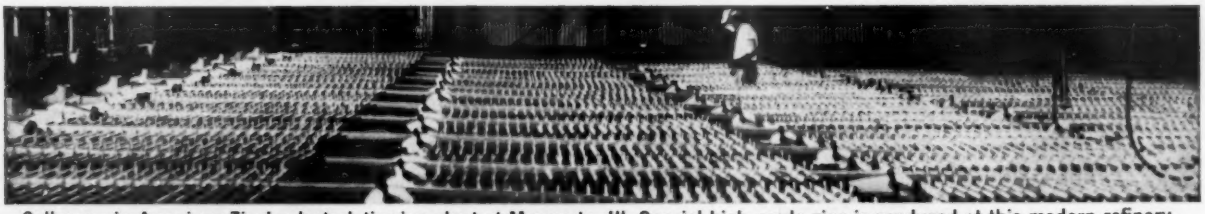
INTEGRATED PRODUCTION—from Ore to Ingot

Underground scene in American Zinc's East Tennessee zinc mines. More than 50 years' reserve of zinc ore has been developed here.

Assures the Uniformity and Purity of



Cell room in American Zinc's electrolytic zinc plant at Monsanto, Ill. Special high-grade zinc is produced at this modern refinery.

AZCO Zinc Die Cast Alloys

Latest spectrographic analyzing equipment is employed to assure accurate control of alloys at all times.

You set your specification—get your specification with AZCO Zinc Die Cast Alloys. AZCO Alloys are produced from American Zinc special high-grade slab zinc—quality controlled from ore to ingot to assure the purity and uniform analysis you need for trouble-free production. From our Monsanto, Illinois, plant in the center of the "Zinc Zone," you get the fast, dependable service you need to meet your production schedules. Phone for immediate attention.

American Zinc sales company

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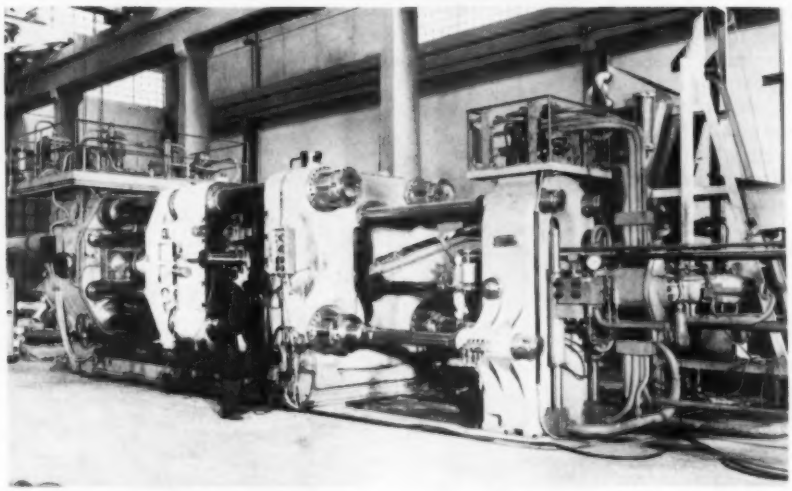
PMM

new products & developments *qualified readers can get complete details on these products. Use the reader service cards.*

2200-Ton Die Casting Machine makes engine blocks

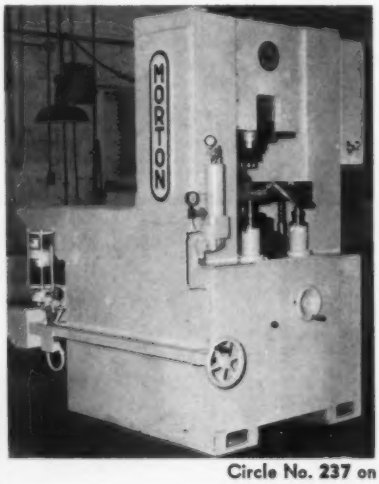


A. TRIULZI—This mammoth die casting machine is the largest of its type in the world. Capable of producing 20 die cast eight cylinder aluminum engine blocks per hour, the machine is operated by one worker, who need only push a button to activate a fully automatic cycle. The 253,531 lb. machine has a clamping force of 2425.5 tons, and a maximum injection force of 187.5 tons, the minimum being 88.2 tons.

During recent tests in Milan, the machine was in continuous operation for five days, during which time it produced four-cylinder engine blocks at a rate of one each three minutes without casting flaws.

Circle No. **235** on Reader Service Card

Automatic compacting press has self-aligning punch holder



MORTON MANUFACTURING CO.—The Dynapress models are available with either 50 or 100 tons of compacting pressure. These machines feature a completely enclosed drive mechanism and a hydraulically controlled float-die table. A variable speed control allows running at optimum speeds for various materials. A smooth acting shuttle type fill shoe loads the die more accurately and permits better powder distribution. The machines also feature a self aligning lower punch holder for faster set-up, and an automatic lubrication system.

Circle No. **237** on Reader Service Card

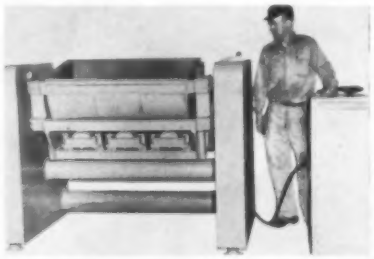
Titanium aluminum additive

HOWE REFINING CORP.—Supplied in a two- or four-ounce piglet form for convenience, this composition titanium additive is used with molten aluminum to obtain alloying of titanium, grain refinement, improved physical properties and enhanced pouring characteristics. The shape of the piglet gives increased surface area for quick dispersion of the titanium, which results in immediate nucleation and grain refinement and markedly shortens the time between alloying and pouring.

Circle No. **236** on Reader Service Card

Vibratory finishing machine

VIBRODYNE DIV., GLOBE INDUSTRIES INC.—Vibrodyne Model V-600, a new 6 cu. ft. capacity vibratory finishing machine uses a unique resonant electro-magnetic system to give shaking forces up to 50 Gs, and features only one moving part—the tub. Shaking force is set by



a single knob, from 0 up to 5/16 inch amplitude, and power is standard 220 v.a.c. operating through three pair epoxy compound impregnated and encapsulated heavy-duty magnets.

The machine can be used for deburring, radii-forming, descaling, flash removal, cleaning and polishing.

Circle No. **238** on Reader Service Card

more Product News on page 24

Wherever aluminum needs heat

Meet "Little Joe"! He looks something like a fellow in our plant but we really use him as a symbol of the good right hand of service Lindberg-Fisher's expert design staff and our complete line of "heat for aluminum" equipment is able to render you.

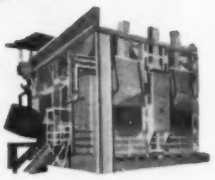
LINDBERG FISHER

You'll find this nameplate on all the equipment you'll need for applying heat to aluminum. Heat and aluminum have been Lindberg's babies for years. Our staff of expert engineers, metallurgists and technicians is widely experienced in all phases of aluminum melting, casting, and treating and has pioneered many important developments in aluminum processing by heat. Today, Lindberg offers you a complete line of heating equipment for every requirement in this field. This includes every needed type of melting, holding or heat treating furnace, large and small, shop built or field erected, fuel fired or electric (resistance, 60 cycle induction, arc or high frequency). We hope you'll let our symbolic friend, "Little Joe", guide you through the exposition of this equipment offered on these pages.

Hot Metal Delivery

MELTING

"RIGHT FROM THE START, LINDBERG EQUIPMENT TAKES OVER YOUR ALUMINUM HEATING NEEDS."

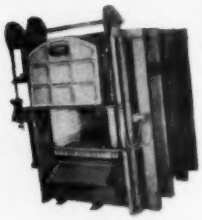


Fuel fired reverberatory. Charging well optional.

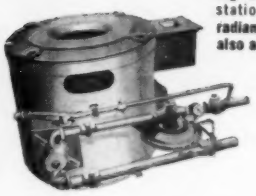
"MOLTEN METAL FROM REDUCTION CELLS IS HELD, OR INGOTS MELTED, IN FURNACES LIKE THESE."

CASTING STATION

"MOLTEN METAL IS HELD AT THE CORRECT TEMPERATURE UNTIL PROCESSED INTO CASTINGS."



Fuel fired reverberatory, holding or melting.

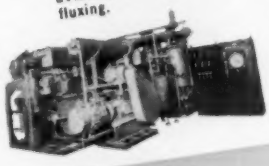


Fuel fired crucible or pot, holding or melting, stationary. **New radiant wall type also available.**

"MANY CASTING STATION FURNACES CAN BE EQUIPPED WITH THE LINDBERG AUTOLADLE, NAMED 'LITTLE JOE', AFTER ME."

Autoladle for automatic ladling, four shot sizes available, up to 100 lbs.

HYNI nitrogen generator, for atmosphere melting and fluxing.



SPECIAL EQUIPMENT

"SOME CASTINGS MAY REQUIRE HEAT TREATMENT AND THESE ARE HANDLED IN THE FURNACES BELOW."

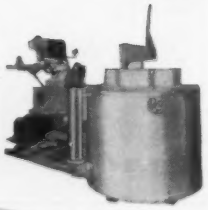
Gas fired billet heater for extrusions.

"SO, DOWN TO THE FINISHED PRODUCT, LINDBERG EQUIPMENT TAKES CARE OF EVERY STEP."

HEAT

Cyclone heat treating, electric or fuel fired, box or pit.

Cyclone heat treating, electric or fuel fired, box or pit.



60 cycle induction billet heater for extrusions.

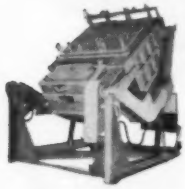
BILLETS **RODS** **CASTINGS**

LINDBERG equipment will apply it

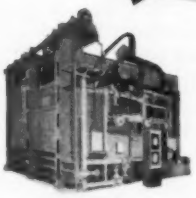
Key
Molten Metal
Solid Metal

Ingot

AND HOLDING FURNACES



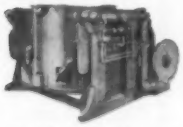
60 cycle two chamber induction, tilting.



Fuel fired double reverberatory. Especially suitable for alloying. Charging well optional.

60 cycle, two chamber induction, tilting; melting and holding.

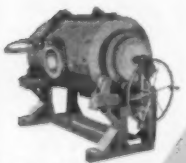
60 cycle induction coreless, tilting, ideal for melting chips.



Fuel fired, crucible or pot, tilting, melting.

Electric resistance, "radiant muffle," Dry-Hearth, melting and holding, nitrogen atmosphere.

High frequency induction, tilting, melting.



Fuel fired, Simplex, rotary, horizontal drum, melting.

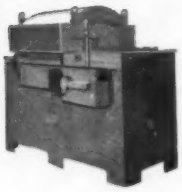
"WHY NOT GET IN TOUCH WITH LINDBERG FOR YOUR ALUMINUM HEATING NEEDS? TELL THEM 'LITTLE JOE' SENT YOU."

MELTING, HOLDING AND REMELT FURNACES

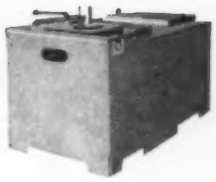
AS REQUIRED, MOLTEN METAL IS TRANSFERRED TO FURNACES AT THE CASTING STATIONS.*

INGOTS CAN ALSO BE MELTED AND HELD IN THESE FURNACES.

FURNACES



Electric resistance, "radiant dome," reverberatory, holding.



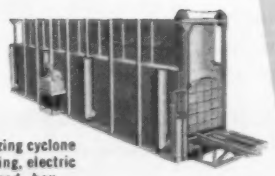
60 cycle, two chamber induction, holding or melting, stationary.

Electric resistance, crucible or pot, holding or melting, stationary.

Fuel fired, Dry-Hearth, two chamber, holding or melting.

GATES, RISERS, SCRAP CASTINGS, ETC. GO BACK TO THE FURNACES AT THE RIGHT FOR REMELTING.

TREATING FURNACES



Homogenizing cyclone heat treating, electric or fuel fired, box.

D. C. INGOTS

Circle No. 55 on Reader Service Card

We'll be glad to discuss your aluminum processing needs with you. Get in touch with your local Lindberg Representative (see your classified phone book) or write us direct.

LINDBERG FISHER DIVISION

LINDBERG ENGINEERING COMPANY

2463 West Hubbard Street, Chicago 12, Illinois

Los Angeles plant: 11937 S. Regentview Avenue, Downey, California. In Canada: Birlnfco-Lindberg Ltd., 15 Pelham Ave., Toronto 9, Ont. Also Lindberg plants in Argentina, Australia, England, France, Italy, Japan, South Africa, Spain, Switzerland, and West Germany.

HERBERT W. WESTEREN, Hayes Ass't Director of R & D, tells about the Hayes way to solve

VACUUM SINTERING

TEST IT! You bring your test compacts to the Hayes lab. where they can be heat treated in production-scale vacuum equipment under varying time/temperature/vacuum conditions. Here you prove BEFORE PURCHASE that your work is right for vacuum sintering, whether it's stainless steel, tungsten carbide, cermets, refractory metals, glass preforms, or other ferrous or non-ferrous materials. You also determine whether or not you need atmosphere-protected presintering — a frequent requirement in this type of processing.

DUPLICATE RESULTS! Next you work with our furnace applications engineers to obtain the exact VACU-MASTER® design you need, taking in consideration: size of workpieces, amount of production, fixturing, temperature range, degree of vacuum, heating and cooling cycles, type and volatility of sinter binder, evolved gases, etc. The lab-proved procedure takes form in a Vacu-Master design engineered for your job — the *right* heating elements and power, the *right* size of heating and cooling chambers, the *right* pumping system, the *right* controls and instrumentation.

Model VAC-50 Series Cubicle Vacu-Master, compact cold-wall vacuum furnace.

RESULTS? GUARANTEED! Hayes Vacu-Masters are right now sintering stainless steels at 2,150°F to 2,300°F (depending on size and analysis of work). They're sintering tungsten carbides at 3,000°F to 3,200°F. They're sintering glass preforms and other electronic components. They're treating titanium, hafnium, zirconium . . . AND THEY'LL TREAT YOUR WORK RIGHT!

TRY HAYES! Take advantage of our store of metallurgical know-how and experience-proved furnace designs. Write for VACU-MASTER vacuum furnace Bulletins 6010-B, 5709-B, 5709-A . . . or ask for a date to visit our lab. C. I. Hayes, Inc., 819 Wellington Ave., Cranston 10, R. I.

C. I. HAYES, INC.

Established 1905

VACUUM ATMOSPHERE FURNACES

It pays to see Hayes for metallurgical guidance, lab. facilities, furnaces, atmosphere generators, gas and liquid dryers, pHayes-Master (TM) power controls, induction generators.

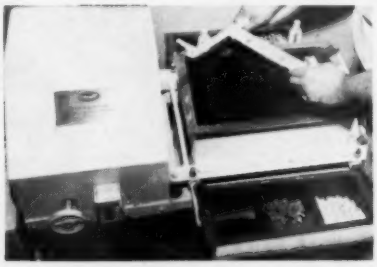
Circle No. 44 on Reader Service Card

new products & developments

Continued from page 21

Piggy-back attachments make additional finishing jobs possible

MINNESOTA MINING & MANUFACTURING CO.—Seven different finishing operations can be completed simultaneously with five side tubs

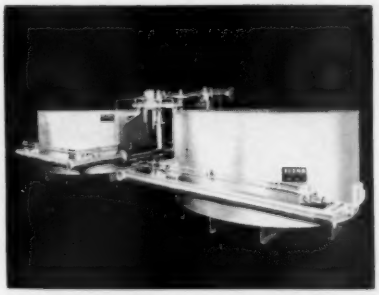


and a divider for the main tub on 3-M's "Honite" brand Vibrahone finishing machine. This is made possible with the use of rubber-lined piggy-back units which are attached to the Vibrahone machine. Either two, three or five piggy-back tubs can be attached.

Circle No. **239** on Reader Service Card

New line of pot-type melting furnaces

J. A. KOZMA CO.—The new Series NF pot-type melting furnaces feature low fuel consumption and a new combustion chamber and flue



area design which assure uniform circulation and distribution of heat to the entire pot surface. These furnaces are designed for melting and holding zinc, aluminum, lead, and Kirksite, as well as other non-ferrous metals.

Circle No. **240** on Reader Service Card

more New Products on page 26

HARDENED STEEL DIE CASTING PLUNGER RINGS by AUTO DIESEL

1" dia. x ⅛" and up

Cut die cast production costs — reduce downtime with rings made by the world's quality ring manufacturer. The hardened steel ring illustrated is resistant to heat and abrasion. Other Auto Diesel products custom manufactured to your specific requirements.

1. Rings of all materials for industrial purposes.
2. Plungers for zinc.
3. Plunger tips and rings for aluminum.

Try it Today . . . . You'll Standardize Tomorrow

THE AUTO-DIESEL PISTON RING CO.
3141 Superior Avenue • Cleveland 14, Ohio

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QUALITY RESEARCH

for your specific alloy

A&M's complete modern laboratory insures that every heat of every alloy meets your exact specifications. In addition our entire staff of metallurgical scientists is at your service in the solution of design, foundry and alloy selection problems. This insures you the very best in top-grade castings at a competitive price.

Remember, the best in finished product can only be made from the best quality alloy.

Producers of Quality Aluminum Alloy Since 1938

ALUMINUM and MAGNESIUM, INC.

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P.O. BOX 156 • Corona, California • Telephone: REdwood 7-2922

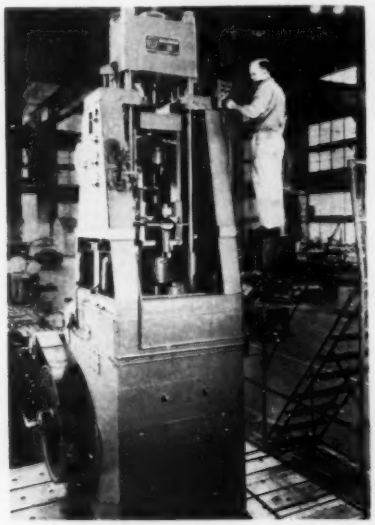
Circle No. 8 on Reader Service Card

new products & developments

Continued from page 24

200-ton compacting press

BALDWIN-LIMA-HAMILTON CORP.—B-L-H's Model 200-B is a four-column, eccentric-gear unit with a 9-inch depth of fill. The unit is of mechanical design, permitting speedier and more economical production of larger powder parts than is possible in equivalent hydraulic presses. The unit has a 12-inch die opening with upper punch die entrance adjustable from zero to five



inches. Production rate is 6 to 24 strokes per minute. Larger parts which can now be produced economically include engine cylinder liners, washing machine bushings, and similar powder iron compacts with total projected surface areas up to five square inches.

The press has a shuttle feed to insure uniform powder fill even in thin-walled compacts. A pressurized lubricating system helps reduce routine maintenance and press down time.

Circle No. 241 on Reader Service Card

Tube-type furnace offers choice of quenches

LINDBERG ENGINEERING CO.—Type RDT15-620AC20 furnace features a choice of quenches for easy adaptability. The furnace has a 6" I.D. Inconel muffle, a 20" long heat chamber, a 20" long water-jacketed cooling unit, and obtains a maximum heating temperature of 2,000°F. A chute between the heat

chamber and the cooling jacket permits either an oil quench or atmospheric cooling. The compact unit is complete with atmosphere flowmeter, piping and valves.

Circle No. 242 on Reader Service Card

more New Products on page 80

Circle No. 61 on Reader Service Card

POWDER CONDITIONING AND PROCESSING

METALLIC AND NON-METALLIC POWDERS GROUND TO YOUR SPECIFICATIONS

- IRON POWDER
- FERRO PHOSPHOROUS
- FERRITES
- MILL SCALE
- COPPER
- TUNGSTEN
- COBALT
- NON-METALLICS
- SOLID CHEMICALS

SCREENING AND PARTICLE SIZE CLASSIFICATION

OPEN TIME AVAILABLE

MICRO METALS CORPORATION

99 President St. Passaic, N. J.
Dept. No. 3A
Member Metal Powder Ind. Fed.

You Get EXTRA VALUES

— when you Specify **DIE CASTINGS** by **MILWAUKEE**

Z

Milwaukee operates under the Certified Zinc Plan of the American Die Casting Institute.

- Extra values provided by the modern Milwaukee plant with every facility for Complete Die Casting Service.
- Extra values provided by more than 52 years of continuous service to industry in producing precision die cast parts for all types of assemblies from small intricate instruments to heavy-duty equipment.
- Extra values provided by die castings which add to the worth of your products in design, appearance, sales appeal and efficient operation.

MILWAUKEE DIE CASTING COMPANY

4146 N. HOLTON STREET · MILWAUKEE 12, WISCONSIN

Established 1909

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PMD . . . and the Direct Chill casting method

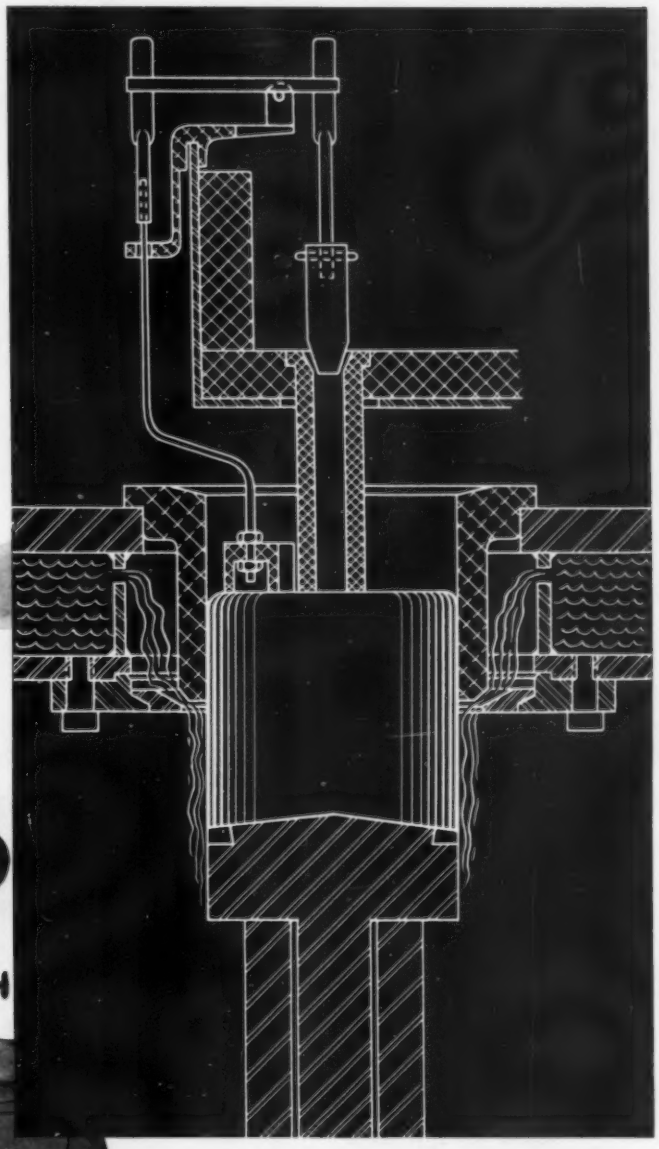
FOR CONTROLLED CASTING OF NON-FERROUS BILLETS

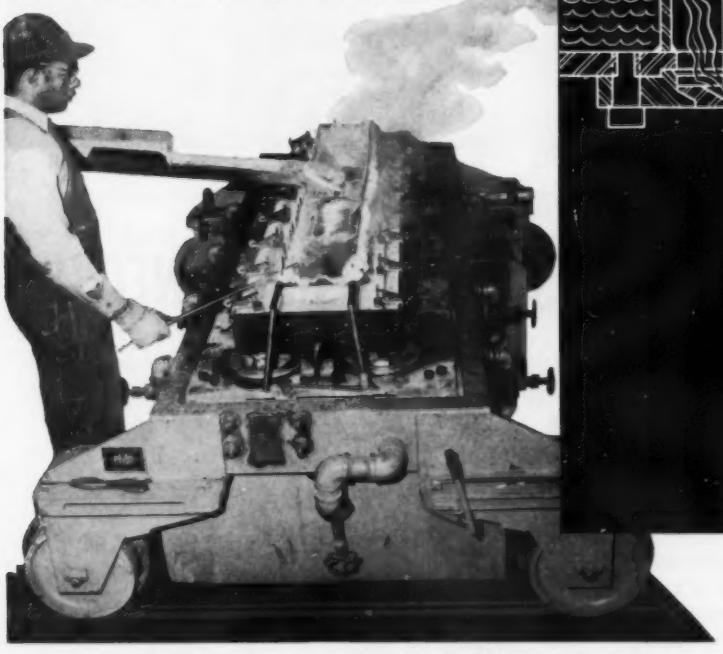
The direct chill method of casting has practically eliminated all of the objectionable defects that are present in most static castings. Because of the controls available to vary the casting conditions, billets cast by this method are particularly sound and free from segregation, porosity, and inclusions. Grain size and structure can be controlled or varied for different applications.

Direct chill casting is accomplished by pouring molten metal into an open end, water cooled mold that is closed at the bottom by a movable block. As the metal solidifies sufficiently to form a skin, the bottom block is lowered at a controlled rate and the direct chill casting is in process. A wide variety of shapes and forms is possible to cast in bar lengths replacing individual castings, resulting in considerable savings in machining and fewer rejects because of casting flaws.

Permanent Mold Die Company is a pioneer in the direct chill casting process. Through the research facilities of PMD, better casting methods are constantly being devised . . . methods that insure higher quality castings at lower costs. And remember, a Permanent Mold Die Co. engineer is available to anyone having die casting or tooling problems.

WRITE TODAY FOR DESCRIPTIVE BROCHURE





PMD

PERMANENT MOLD DIE COMPANY

2275 E. Nine Mile Rd. • Warren, Michigan • Phone: SLocum 7-8100

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Now from stock... DS CAST STEEL GOOSENECKS!

Whatever your die casting machine, you can now order longer-lasting* Dodge cast steel goosenecks *from stock*, machined and sleeved . . . ready for your use.

Pictured here are just a few of the many Dodge cast steel goosenecks that are available . . . ready for shipment.

Check the ones that fit your machines—then ask us for a quotation. If you don't see your particular gooseneck, ask us about it. Chances are we've made it and it's available. What's more, a wide variety of cast steel replacement die casting machine parts are available from stock, too.

Why not write us today, while you think of it? We'll be happy to furnish complete details, without obligation.

**Users report better than 5 year service life!*

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THE MOST IMPORTANT ALLOY IN A STEEL CASTING IS QUALITY

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FIRE PROTECTION WITH HUL-E-MUL®

REG. U. S. PAT. OFFICE

FIRE-RESISTANT HYDRAULIC FLUID

GUARANTEED to cost no more than conventional hydraulic oil.

HULBURT will *guarantee* that your cost of using HUL-E-MUL will be no greater than when using conventional hydraulic oil. In fact, wherever HUL-E-MUL has been used, it has invariably *lowered* hydraulic cost!

HUL-E-MUL ASSURES:

- Longer pump life. Field-proven in over 1,000 pumps. All types.
- Complete compatability with seals, paints, hoses and packings used with petroleum oil.
- Approved by U. S. Bureau of Mines as a fire-resistant hydraulic fluid after severe testing.

Send today for a technical bulletin describing HUL-E-MUL.

CIRCLE NO. 48 ON READER SERVICE CARD AND MAIL TO PRECISION METAL MOLDING

you're always right in specifying HULBURT

HULBURT OIL & GREASE CO., TRENTON & CASTOR AVES.
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Industrial Lubricants Department

43 Stories of Cast

Cast aluminum spandrel is locked in place on the 41st floor.

Note the alternate window-spandrel design and the elimination of horizontal bars creating the high-rise appearance. One of the unlimited possibilities of cast aluminum panel construction.

Aluminum Spandrels

N.Y. Skyscraper Creates New Markets for Cast Aluminum

It took new foundry skills and engineering bravado—but 750,000 pounds of aluminum and 6,500 castings later New York has a new skyscraper, a bank has new quarters, and cast aluminum has earned a new reputation!

The First National City Bank Building at 53rd and Park Ave., New York, pioneered new methods of building design and construction. It proved the time-saving, money-saving, versatile features of cast aluminum spandrel construction.

Orberdorfer Foundries, Inc., Syracuse, N.Y., produced the castings. Seven basic patterns, with minor variations, met all requirements. Spandrels were cast in jolt-rollover draw equipment from Reynolds Alloy 43. Sizes ranged from 4 ft. x 4 ft. to 4½ ft. x 9 ft.

After sand blasting and heat treatment they were anodized to a permanent blue-gray, protected with temporary plastic, and shipped to the construction site as needed.

On the job, spandrels were easy to handle, ranging from 75 to 200 pounds. They were delivered, a floor at a time, and locked into place between the mullions. Flexible design and low construction costs were made possible by casting window mounts, flanges, and bosses as an integral part of the spandrel.

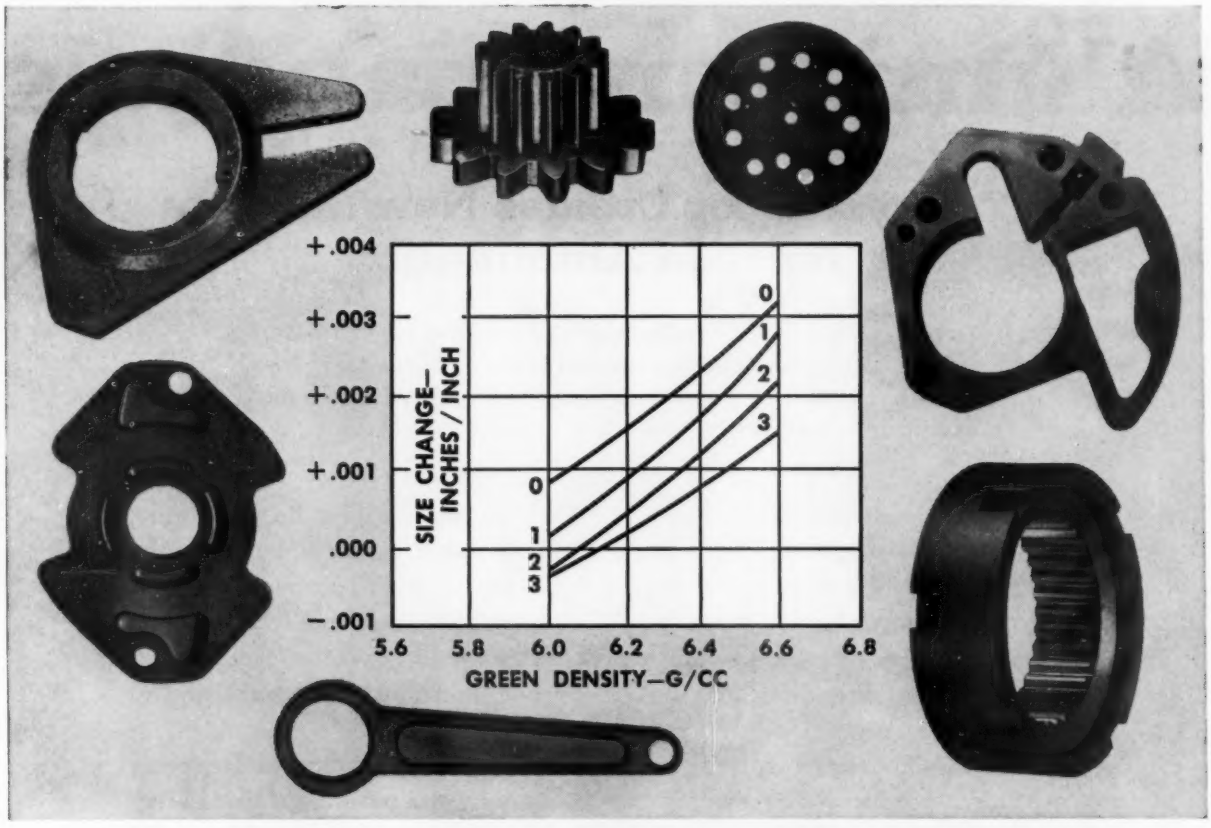
Gleaming, weatherproof Reynolds Aluminum will never need refinishing. It is immune to fungus, mildew, and termites. It keeps the building cooler in summer, warmer in winter.

Reynolds offers many alloys for permanent mold, sand mold, and die casting, plus marketing and research information to help you develop new markets for aluminum castings. Contact your Reynolds Ingot Distributor, your nearest Reynolds Branch Office, or write *Reynolds Metals Company, P. O. Box 2346-FP, Richmond 18, Va.*

REYNOLDS ALUMINUM

Watch Reynolds exciting TV programs on NBC: The Dick Powell **Reynolds Aluminum Show** every other Tuesday; **Say When**, weekdays; **All Star Golf**—in living color—every Saturday.

Circle No. **76** on Reader Service Card



Better dimensional control, with economy ...when you use A.W. Iron Powder

Little differences in the carbon additive to A.W. Iron Powder can make big savings in your plant.

By use of different types of carbon additives, in iron-copper-carbon mixes, a broad range of dimensional control can be achieved. This provides not only greater latitude in design specifications, but prolongs the service life of your dies. Together, these advantages result in closer tolerances for your molded parts at reduced production costs.

The curves shown above indicate the range of dimensional change obtainable with various types of carbon. *The cost of all these grades is almost identical.*

The Alan Wood 50-ton-a-day direct reduction plant, backed by years of metallurgical research, offers you the most advanced technology in Iron Powder. Make Alan Wood your Iron Powder headquarters for dependable uniformity and delivery, as well as technical advisory service.

ALAN WOOD STEEL COMPANY
CONSHOHOCKEN, PA.

FOR MORE INFORMATION

Please send me A.W. Technical Data Bulletin #3, which gives additional details on copper-carbon additives.

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IRON POWDER DIVISION
ALAN WOOD STEEL COMPANY
Conshohocken, Pa.

AMERICAN STEELMASTERS FOR 135 YEARS

Circle No. 4 on Reader Service Card

HERE'S WHY...

POTOMAC® M IS THE FASTEST GROWING DIE STEEL IN THE DIE CASTING INDUSTRY

- ***Product Quality*** —the characteristics and properties you require in a die block . . . the machinability, stability, response to heat treatment . . . the *right* grade for your job.
- ***Facilities*** —unmatched, by anyone, anywhere . . . production equipment specifically designed for the job at hand.
- ***Availability*** —stock on the shelf, finished and ready for you . . . and job-shop delivery schedules, the industry's most dependable.

3702-1

PRODUCT QUALITY through...

Die quality clear to the center . . . upset forging quality . . . and in pressed billet stock! That's what puts Potomac M . . . A-L's H-13 Die Steel . . . in a class by itself. And *that's* the kind of quality that's absolutely mandatory for the intricate interior patterns in today's complex diecasting dies.

Quality like this has been associated with Allegheny Ludlum Die Steels over the past 20 years, during a period when die blocks were generally running less than 1200 pounds. Holding rigid specifications on ultrasonic soundness, grain size, and response to heat treatment in blocks of this size was one thing. Offering consistently higher quality in much larger die blocks . . . more and more the rule these days . . . is something else again.

But, Allegheny Ludlum has become *the* specialist in doing just that . . . in providing these massive chunks of steel with the same center quality, machinability, and mechanical properties generally associated with much smaller sections.

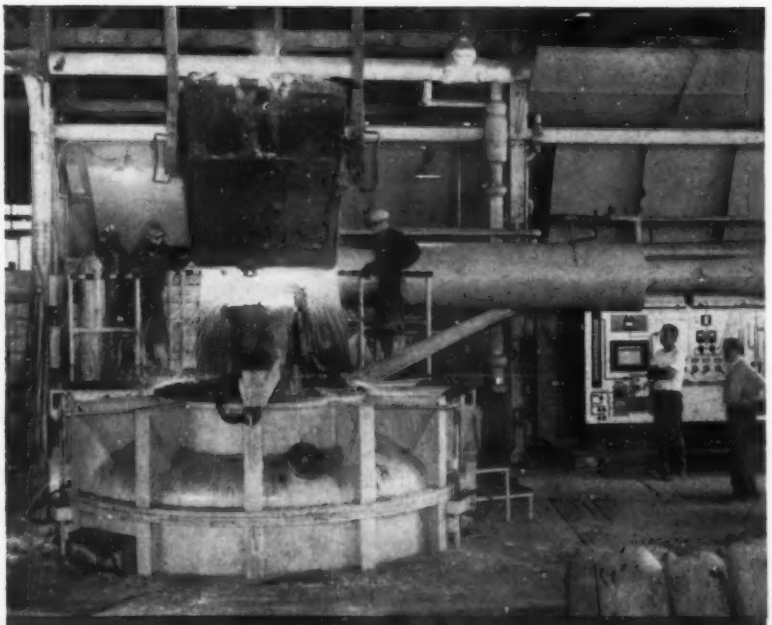
And here's what it means to you

It means that Potomac M dies have greater strength in the transverse direction, and combine the ultimate in toughness with machinability and size stability. It means water cooling channels may be employed without the risk of cracking your dies due to thermal shock. It means better resistance to abrasion and softening at elevated temperatures . . . and, greater resistance to wash and heat checking. Most important, it means Potomac M is specifically created, and specifically processed for you . . . the most practical and useful material for your diecasting needs.

...A-L's 2,000 Ton Forging Press

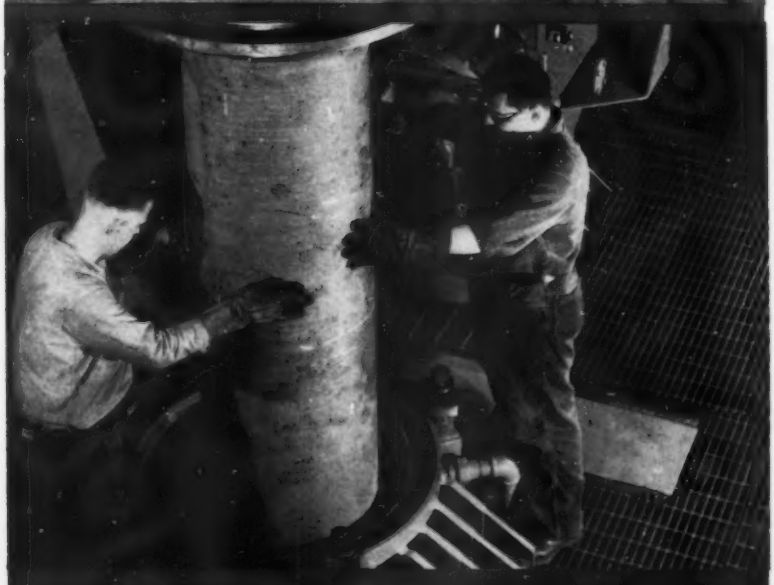
Production equipment specially designed for the job at hand is part of the story. The direct pumping facility and fast, closely controlled action of A-L's unique forging equipment permits greater reductions in area from ingot to billet in a single heating, and results in complete ingot reduction in a relatively short time, with fewer reheats necessary. Coupled with A-L's ability to produce ingots up to 40″, of superior quality as-cast, the capacity of this press to rapidly and *completely* work such ingot grain structure inevitably results in an exceptionally high center quality in the billet, together with a refined grain structure more responsive to heat treatment. Substantially improved mechanical properties are obtained in the forged die blocks, with particular improvement in transverse tensile strength and ductility.

3702-2



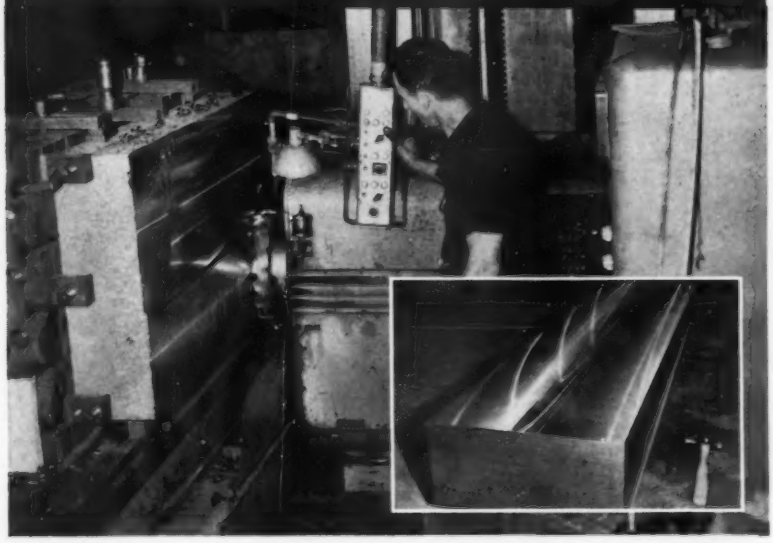
...A-L's Vacuum Degassing

Potomac M Die Steel is vacuum degassed . . . as a matter of routine. Vacuum degassing results in a cleaner steel, without blemishes or subsurface discontinuities . . . those imperfections which often reveal themselves in the die only after considerable machining has been done. Vacuum degassing produces a steel with lower oxygen and hydrogen content, with greatly reduced tendency toward microcrack formation, with fewer nonmetallic inclusions . . . a steel with better, more reliable mechanical properties clear through.



...A-L's Special Melting

For the unusual die applications requiring the ultimate in cleanliness and center quality, Allegheny Ludlum now offers its Consutrode® Potomac M. For requirements involving a super-finish die, the superior cleanliness of this vacuum melted product assures the die maker of an unblemished working surface clear through the workpiece. Equally important, this vacuum melted steel provides an improved transverse ductility in large die blocks, particularly applicable to dies which require the ultimate in toughness and resistance to thermal shock.



...A-L's Machined Finish

All bars and blocks in the larger sizes are milled to a finish that permits die layout right on the steel we ship. Finished closer to final size, there's much less wasted metal to wind up as chips on the floor of your shop. Allegheny Ludlum Potomac M die blocks are delivered to you free from scale and decarburized surface areas, and ready for your diemakers.

3702-3

AVAILABILITY

Allegheny Ludlum's Potomac M is part of the Steelector Program, a unique system which enables tool steel buyers to select the proper steel on the basis of intended application, and check on the availability of the desired size and shape before any purchase decision is made or any paperwork issued. Individual Data Stock Lists for each Steelector Grade clearly set forth the size and shapes of bars and billets available from stock . . . sizes which will serve the requirements of all users. This is all finished stock . . . over 320,000 pounds of Potomac M . . . on the shelf, ready for you. And, it's backed up by over 180,000 pounds of Potomac M billet stock, ready at the mill for finishing to your specifications, should the size, weight or shape of your order take it out of depot stock category. To learn how you can take advantage of this special stocking plan on tool and die steels, contact your local A-L Representative, and ask him about the Steelector Program and the job-shop availability of special sizes, or write Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.

Back-up stocks of ingots and billets insure job-shop delivery schedules on mill shipments. Here, Potomac M billet stocks at the Dunkirk Plant of Allegheny Ludlum await finishing operations.

A corner of an Allegheny Ludlum Warehouse, with part of the finished stocks of large Potomac M die blocks that permit customers to quote on short delivery jobs without expensive inventories.

STEELECTOR PROGRAM

ALLEGHENY LUDLUM

Tool Steel warehouse stocks throughout the country

3702-4

Circle No. 5 on Reader Service Card

For safer, faster diecasting —

EMB Nos 10 & 12A

No fire risk—they're powered by compressed air at 150 lbs./sq. in., controllable by a self-contained hydraulic system—with no slam.

Simple to operate and robust in construction, they can be easily serviced by any good mechanic—there are no electrical gadgets.

Manual control for setting up, automatic for production.

Zinc furnace fired by coal gas, natural gas or oil.

Takes only 2 hours to convert from hot to cold chamber.

MACHINE SIZE	No. 10	No. 12A
Wt. per shot zinc base lbs	2¾	6.3
Wt. per shot aluminum lbs	1¼	2.1
Max. die	16" x 10"	20" x 12½"
Platen stroke	6"	8"

Larger sizes available

E. M. B. Co. Ltd.
WEST BROMWICH • ENGLAND

EMB No. 10 Automatic Diecaster for Zinc

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Eliminate costly machining with

INVESTMENT CASTINGS

Do your small parts have 4, 5 or more machining operations?
Do they require materials that are difficult to machine?
If so, you should investigate V-R Investment Castings. Machine operations are entirely eliminated, yet intricate details are held to exacting tolerances. You can design for function regardless of shape. Multiple parts are often produced as single units. V-R engineers can develop and cast the proper material to meet the requirements of your application. Send us your specifications today.

COMPLETE DESIGN FREEDOM
without compromise for production limitations.

WIDE CHOICE OF ALLOYS
to meet your requirements for resistance to heat, corrosion and wear.

CLOSE TOLERANCES MAINTAINED
throughout entire production quantity.

EXPERT METALLURGISTS AND ENGINEERS
make recommendations on your application.

PARTS SHOWN ACTUAL SIZE

CREATING THE METALS THAT SHAPE THE FUTURE

VASCOLOY-RAMET

872 MARKET ST. WAUKEGAN, ILLINOIS

I-836

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PMM

news of industry & associations *activities of people, companies & groups in the precision metal molding industries*

promotions & changes

National Lead Co., Doehler-Jarvis Div.—*Alfred F. Bauer* has been appointed manager of the Doehler-Jarvis Div. Bauer was previously assistant general manager and was responsible for the division's research and development program.

Southern Die Casting & Engineering Corp.—*Earl W. Rearwin* has been named president. For four years previously, Rearwin has been chief engineer at Reed-Prentice, and will remain on the engineering staff there in an advisory capacity.

Dixon Sintaloy Inc.—*Philip R. Lochner* has joined the firm as general sales manager.

Mallory Metallurgical Co.—*H. James Fillenwarth, Jr.* has been promoted to controller. He has been Mallory's chief accountant since January.

Cannon-Muskegon Corp.—*Peter Stefan* has been appointed sales manager. He was previously with Western Gold & Platinum Co.

American Zinc Institute, Inc.—*Lewis E. Gage* has been appointed to the market development staff. He was previously advertising and sales promotion manager for Burndy Corp.

Micro-Metals Corp.—*Michael K. Tudor* has been named executive vice president and a director of the firm. He is also president of Allied Industries, Inc. and Tudor Industries, Inc.

more on next page

ICI holds ninth annual meeting

The ninth annual meeting of the Investment Casting Institute will be held November 1-2, 1961 at the Park-Sheraton Hotel in New York City.

The "Presidents' Roundtable" and the annual meeting of the ICI will be held on Wednesday, November 1. The "Roundtable" is attended by presidents and general managers of regular member companies, where the management programs of the ICI are discussed. Such topics as the distribution of the ICI book "How to design and Buy Investment Castings" and other co-operative promotional programs will be discussed.

On Thursday, November 2, 1961 ICI will sponsor a technical session devoted to discussing new developments in the investment casting industry.

J. M. Webb, H. J. Sherwood Co., Inc., and R. A. Applewhite, American Lava Corporation, will discuss the merits, usefulness, and economics inherent in preformed ceramic cores. Irwin Lubalin, Shaw Process Division, will discuss new developments in the Shaw Process.

Professor M. C. Flemings, M.I.T., will review research on investment castings being done at M.I.T., T. F. Kaveny, Union Carbide Metals Company, will present a paper on deoxidation practice – principle and and application.

David Hoadley, Hitchiner Manufacturing Co., will discuss investment casting technical developments in Europe.

Additional information regarding ICI's Ninth Annual Meeting can be obtained from the Investment Casting Institute, 27 E. Monroe, Chicago 3.

Vanadium-Alloys men receive patent

Two Vanadium-Alloys inventors, William L. Batten and George A. Roberts, received a patent recently from the United States Patent Office as a result of several years of research and testing to develop improved equipment with which to atomize molten metal for the production of prealloyed powders.

A key feature of the invention is an improved nozzle design within the powder disintegrator which permits better direction of the liquid or gas spray jets against the molten metal stream, thereby providing increased control of powder particle shape and quality.

Powders made with the new equipment are said to be of higher quality, with lower surface oxide, better green strength, and a more desirable shape for molding into structural parts.

more Industry News on page 41

BAUER

REARWIN

LOCHNER

FILLENWARTH

STEFAN

GAGE

use Southwestern

MICROCRYSTAL GRAPHITE

for Copper and Bronze Compositions and for Increased Hardness In Structural Iron Parts

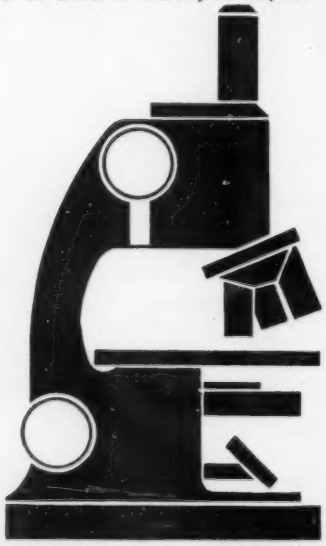
SINTERED PROPERTIES

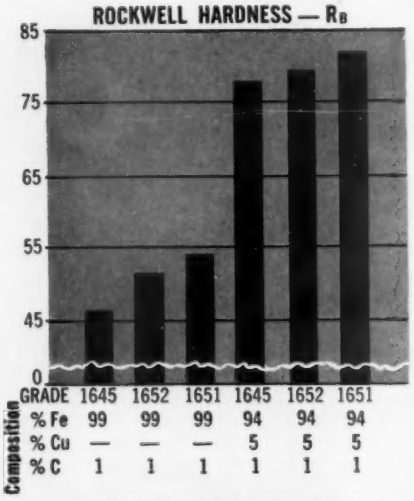
of Iron-Microcrystal Graphite and Iron-Copper-Microcrystal Graphite Compositions

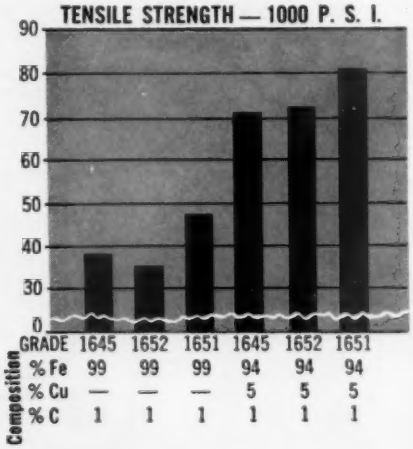
M P I Standard Bars — Sintered at 2050°F — 10 min. Atmosphere of Cracked Ammonia — Continuous Production Furnace

TOTAL CARBON AFTER SINTERING	GREEN DENSITY
Grade 1645—.81%	6.4 gm/cc
Grade 1652—.84%	ELONGATION (% in 1")
Grade 1651—.86%	99% Fe—1% C
	Grade 1645—2.5
	Grade 1652—2.0
	Grade 1651—3.0

Send for a test sample (no charge) of one or all Grades of Microcrystal Graphite.







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promotions & changes

Continued

Paragon Die Casting Co.—*Harold H. Bush* has been named sales manager in the Detroit area.

Misco Precision Casting Co.—*Richard W. Arter* has been appointed sales manager of Airfoil Products, *James H. Boyle* is sales manager of Special Products, and *Rex Eberly* is sales manager of industrial products.

Aluminum & Magnesium Inc.—*A. M. Randolph Charrington, Jr.* is the new Eastern representative. He was formerly vice president of sales for North American Smelting Co.

Oakite Products, Inc.—*Robert P. Jones*, formerly New England division manager of the firm, has been assigned to the New York headquarters. He is succeeded in New England by *Roger R. Heroux*, who was the representative in Springfield, Mass.

Pangborn Corp.—*John V. Haider* has taken the post of manager of the Pittsburgh sales district, succeeding *John D. Wise*, who recently retired. *Melvin R. Price* has joined the firm as sales engineer in the Pittsburgh district.

Apex Smelting Co.—*William R. Bayer* has been elected president of the firm's subsidiary in Long Beach, Calif. *David Schiffer* has been elected assistant vice president in Cleveland, and *Erik Windmiller* has assumed the same capacity in Chicago.

Crucible Steel Co. of America—*William G. Scharnberger* has been appointed to the newly created position of sales manager of the Magnet Division. He was formerly manager of Spaulding Cast Specialties.

Ipsen Industries, Inc.—*Charles W. Brunstetter* is general manager of the firm. He was previously vice president of Astro-Metals Corp.

Metals Disintegrating Co., Div. of American-Marietta Co.—*John B. Haertlein* has been appointed chief metallurgist.

Olin Mathieson Chemical Corp., Metals Div.—*Derek Richardson* has been named vice president-marketing, Chemicals Division, and has been succeeded by *Fred H. Edgar*, who is now division vice president—aluminum sales in the Metals Division. *Edward B. Reynolds* has been appointed assistant director of aluminum field sales, and *Charles I. Vogel* has been named manager of the Eastern sales region.

news of industry & associations

Continued from page 39

Warwick moves into new plant

Warwick Industrial Furnace & Engineering Corp. recently announced the relocation of its plant and offices to 9219 Park Ave., Franklin Park, Illinois, a suburb of Chicago. The firm was formerly located on West Chicago Avenue in the city proper.

American Sinterings changes name

Engineered Plastics and American Sintering, Inc., of Watertown, Conn., has officially changed its name to Engineered Sinterings and Plastics, Inc.

The firm has started to clear land to begin construction of a new 22,000 square foot building located in a recently-opened industrial park in Watertown.

Micro Metals wins steel contract

A three-quarter million dollar contract for the production of 18,000 gross tons of steel briquettes has been awarded to Micro Metals Corp.

The briquettes, weighing approximately ten pounds each, will be exported to a leading Japanese steel producer for use as an additive to steel in the production of ingots.

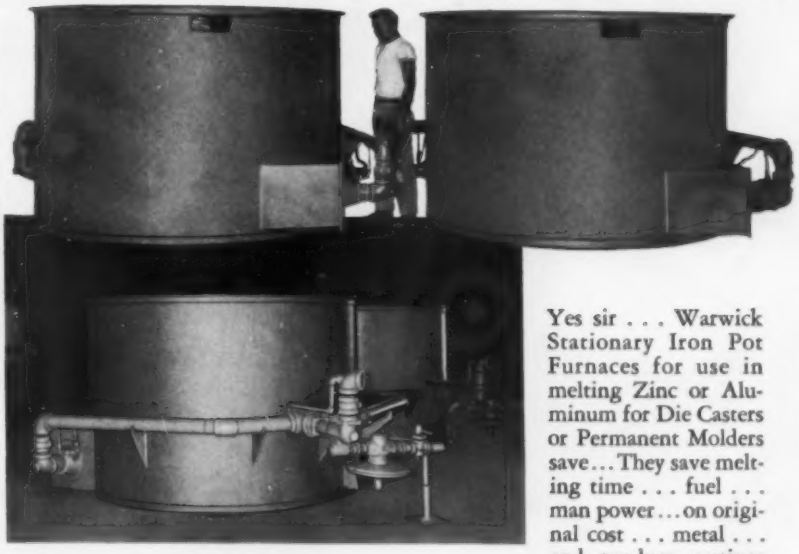
Stokes opens western office

F. J. Stokes Corp. has opened a new West Coast facility at 3761 E. Colorado Blvd. in Pasadena to provide close-at-hand engineering representation and technical service and prompt deliveries from stock of many of its standard items of equipment for vacuum processing, molding, tabletting and compacting.

F. Theodor Hahn has been appointed district manager in charge of the new facility. Albert V. Bicknell has been named sales engineer for the press division, with James A. Fox as sales engineer for the vacuum equipment division. John A. Kershaw has become district service engineer.

WARWICK IRON POTS FOR DIE CASTERS

The $avingest Furnace You Can Buy



Yes sir . . . Warwick Stationary Iron Pot Furnaces for use in melting Zinc or Aluminum for Die Casters or Permanent Molders save... They save melting time . . . fuel . . . man power... on original cost . . . metal . . . and produce castings of such a superior quality that rejects are at a minimum. In fact, they save you . . . money!

Designed and built by Warwick Foundry Engineers and backed by over a half century of operational experience, each and every Warwick Furnace assures highest efficiency, economy of operation and years of trouble-free service. Capacities range from 125 to 10,000 lbs. of Aluminum or 350 to 27,000 lbs. of Zinc.

FOR LARGER CAPACITIES, FOR THE SMELTER, EXTRUDER, BILLET CASTER OR ANY OTHER PURPOSE, WARWICK MAKES THE BEST DOUBLE CHAMBER, DRY HEARTH AND REVERBERATORY FURNACES . . . ANY SIZE DESIRED

WARWICK STATIONARY CRUCIBLE ALUMINUM MELTING FURNACES

Here is a furnace that will prove a decided asset to any Die Casting or Permanent Mold Plant. Used as a breakdown or holding furnace or both it will produce perfect metal for casting at the rate of 200 to 1000 lbs. Aluminum. It is designed for utmost efficiency and economy. Ease of operation and operator comfort is assured by the extra wide dip out opening and the built in heat shield.

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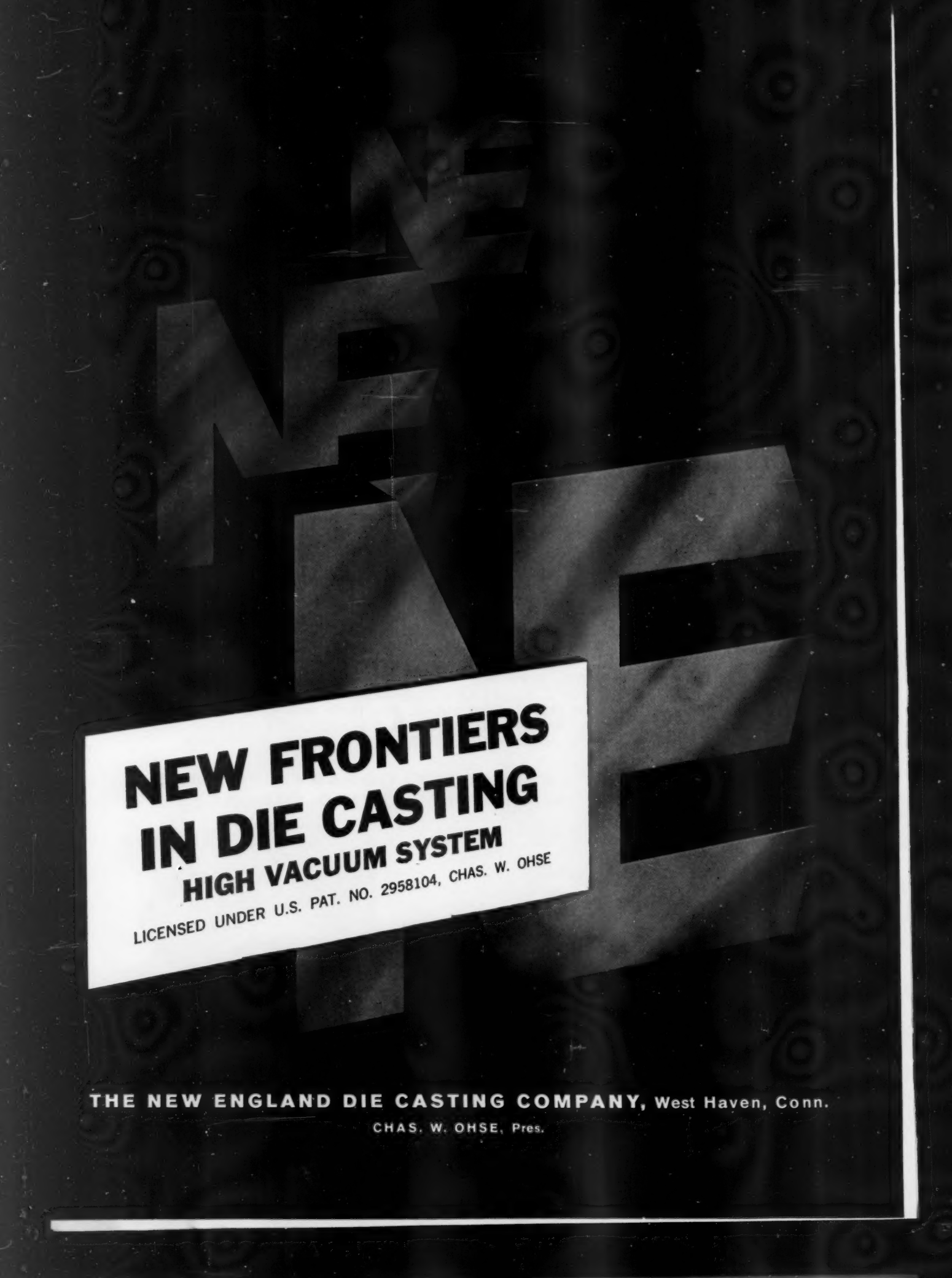
NEW FRONTIERS
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THE NEW ENGLAND DIE CASTING COMPANY, West Haven, Conn.
CHAS. W. OHSE, Pres.

Precision
Metal Molding
OCTOBER 1961

METAL CHOICE

RELYING on vendors' recommendations for specifying alloy is usually a sound practice. Reliable vendors know what can be done with the metals they cast, extrude or compact. And following, or at least requesting, vendors' recommendations is a partial safeguard against overdesign and unnecessarily high part costs.

There obviously should be limits. A designer worth his salt won't let the recommendations of vendors be his crutch, his escape hatch for not knowing the properties of processes and alloys. Suppose a designer deals only in parts offering no real design challenges? Still, he limits his outlook and potential if he does not learn more material properties.

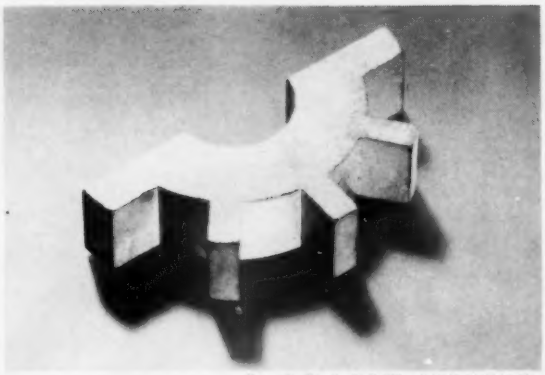
For example, how many designers know which die casting alloy resists high temperature creep under heavy load? What powder blend produces a powdered metal part with an ultimate tensile strength of 85,000 psi? What alloy and process produces parts with ultimate tensile strengths of 180,000 psi? Can die castings be held to tolerances in the tenths of thousands?

These questions were drawn from case histories discussed in this article. Naturally, no designer would be expected to know the answers to questions such as these at the drop of a hat. But the questions do show some of the intricacies of alloy and process selection. They show how designers are combining alloy and process to meet both common and unusual requirements.

For a handier, more complete tabulation of physical and mechanical properties, cataloged according to process, consult the tables beginning on page 60. And watch future issues for conprehensive articles about many of the parts discussed in the case histories.

Bronze powdered metal part resists wear

This part is half of a protective collar used as an insert in a zinc die cast sacrificial collar. The collar is placed on a power boat propeller shaft and is attacked by the electrolytic action from the boat's electrical system. As the collar corrodes, it saves the propelier and propeller shaft from this same electrolytic action. A solid zinc collar wears and becomes loose, but the bronze insert keeps the fit tight.



Russell, Burdsall & Ward Bolt & Nut Co.

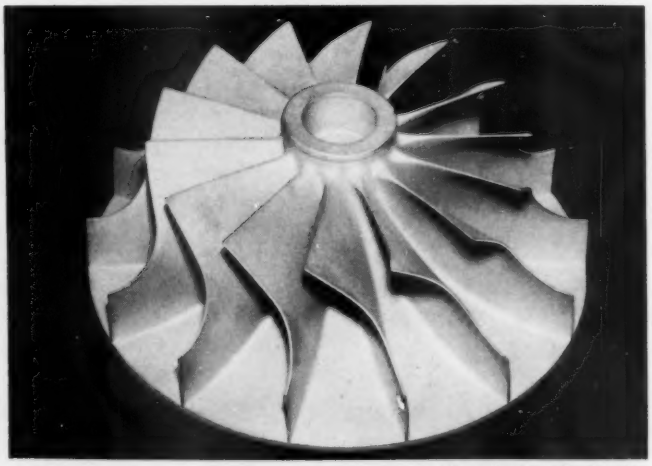
Nickel brass plaster mold casting meets sanitary specs for food machinery

All exposed parts on food processing and packaging machinery must be kept clean and free of contamination. Surface finish must not have any pit marks in which bacteria or contamination can lodge. That is why this part was made as a 22% nickel brass plaster mold casting. The alloy polishes to a mirror finish similar to stainless steel. This makes it easy to keep clean.

Universal Castings Corp

C-355 aluminum investment casting keeps centrifugal stresses low

For parts which spin at high rotational velocities, centrifugal stresses must be carefully considered. That's why this turbocharger impeller was made as a C355-T61 investment casting. Investment casting permitted the complex shape, and specifying aluminum kept centrifugal stresses low. C355-T61 was chosen as the alloy because of its high strength and because it yields very sound castings. This alloy has mechanical properties superior to 355. C355's ultimate strength is 5000 psi higher, yield strength is 1000 psi higher, and its elongation is 10% instead of 4%.

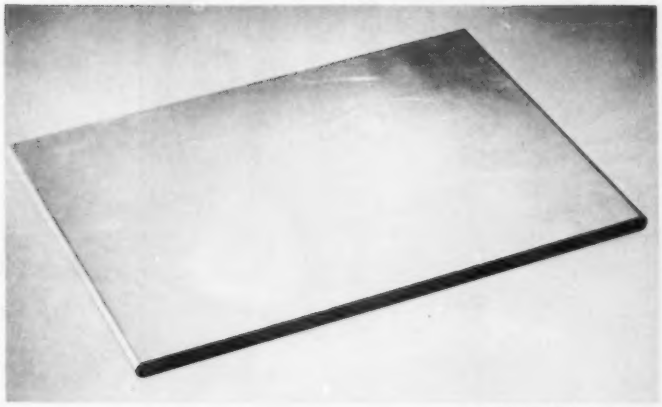


Misco Precision Casting Co.

Cramer Posture Chair Co., Inc.

A108 aluminum permanent mold castings are easy to remove from mold

Generally, silicon aluminum alloys cast best in permanent molds. As a permanent mold casting solidifies on the male parts of the die, shrinkage stresses develop. This requires that the casting must deflect slightly to facilitate removal from the mold. Silicon aluminum alloys like A108 will give where others will break during solidification in the mold. For this reason A108 was chosen as the alloy for this office chair seat base.



Precision Extrusions, Inc.

E.C. aluminum extrusion is highly conductive

E.C. aluminum, the material from which this bus bar is extruded, has a minimum electrical conductivity of 61% of International Annealed Copper Standard at 20°C. E.C. is 99.45% pure aluminum and high electrical conductivity is about its only virtue. Typical yield strengths are only about 4000 psi, while ultimate tensile strength is 12,000 psi. However, 2-E.C. has been developed with substantially improved mechanical properties with a very small decrease in electrical conductivity.

Jervis Corp.

Aluminum 13 die casting has thin walls, good properties

This die cast swivel connector for a vacuum floor cleaning appliance must have thin walls, close tolerances, and better than average corrosion resistance. Also, it must have low porosity because it is used at low pressure. For these requirements, aluminum 13 has the most suitable properties. This alloy is also often used for large parts with intricate, thin sections.

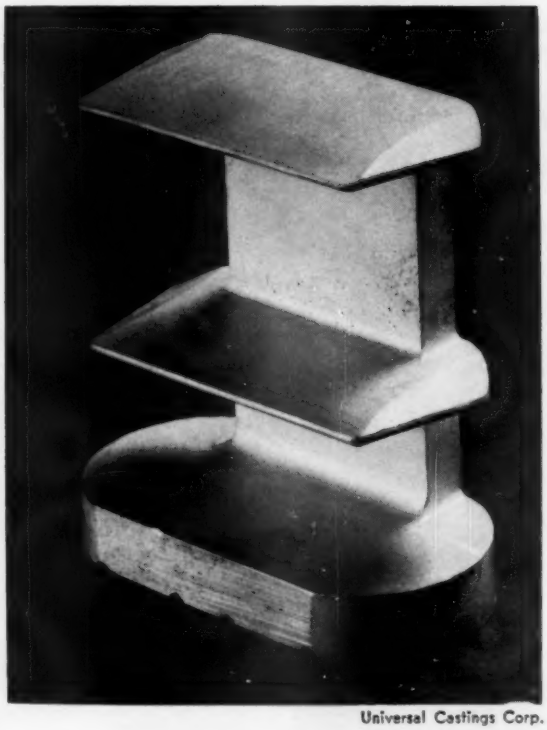
Aluminum 218 die casting meets strength and finishing requirements

Two requirements were placed on the die cast trigger guard for a rifle. It had to have good strength and ductility, and it had to take a jet black anodize. 218 aluminum offered the best combination of these properties. It has a 27,000 psi yield strength, a 45,000 psi ultimate strength, and an 8.0% elongation. Anodized appearance is excellent. This alloy also holds up well in fatigue applications.

Doehler-Jarvis Div., National Lead Co.

Copper plaster mold casting has good electrical properties

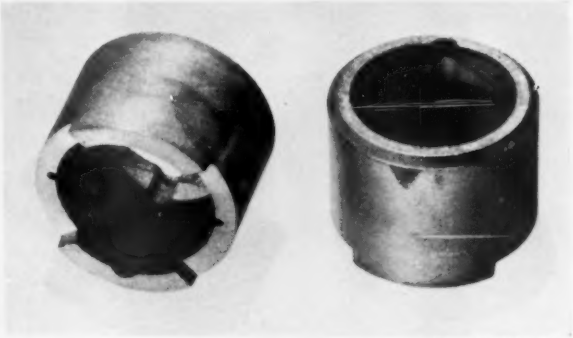
Pure electrolytic high conductivity copper was selected for the plaster mold cast contactors used in transformer switch gear equipment. This material has a conductivity rating of 85% or better. The metal for the contactor is vacuum de-gassed and poured into evacuated molds to obtain a very dense part with the greatest possible current carrying capacity. The electrical contacting surfaces are cast to a degree of smoothness which eliminates secondary finishing operations.



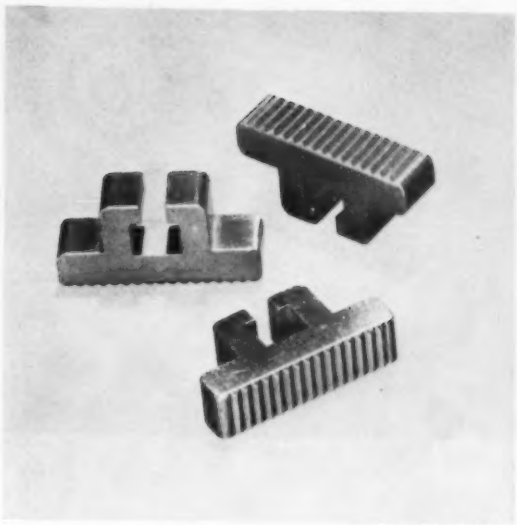
Universal Castings Corp.

Copper infiltrated part has good mechanical properties, low porosity

The powdered metal sleeve for a high pressure air hose coupling has several important requirements. It must have sufficient ductility to allow easy production knurling of the outside diameter. It needs sufficient tensile and impact strength to withstand repeated rough handling. Also, it must not have micro-porosity because it is cadmium plated. To meet these requirements an iron, carbon, copper infiltrated material was selected. A fully copper infiltrated structure and 0.6 combined carbon provide ample margin to meet the requirements.



Dixon Sintaloy Inc.

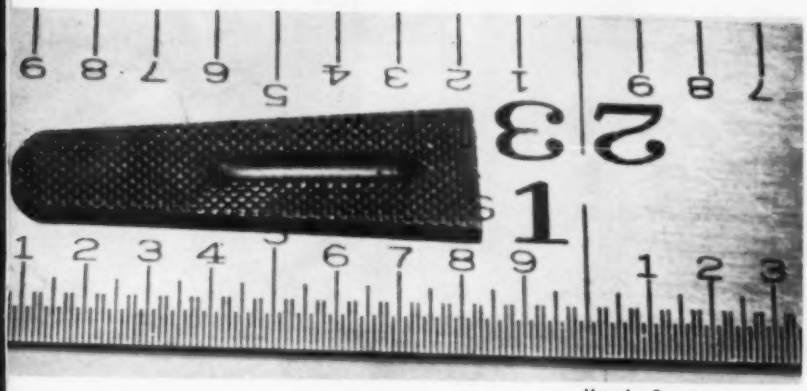


Dixon Sintaloy Inc.

Powdered metal transformer part has high corrosion resistance

The powdered metal main element for an electrical connector in a power transformer must have sufficient corrosion resistance to withstand long term atmospheric exposure in contact with copper and aluminum wire. It also needs strength and hardness to take high compressive forces applied when tightening the connector. Of course, it must have high electrical conductivity.

To meet these requirements the part was made from a prealloyed nickel silver having a nominal composition of 64% copper, 18% nickel, with the balance zinc. Density is held at 7.8 grams/cc.



Vascoloy-Ramet

Tantung investment casting resists wear and corrosion

Jaw inserts for surgical needle holders are investment cast in a proprietary complex carbide alloy, Tantung. This alloy's high castability enables the casting of an intricate knurl to hold the surgeon's needle. The alloy's wear resistance keeps the points of the knurl from wearing down, yet the points don't scratch the needles. The alloy also holds up under frequent contact with highly corrosive body fluids.

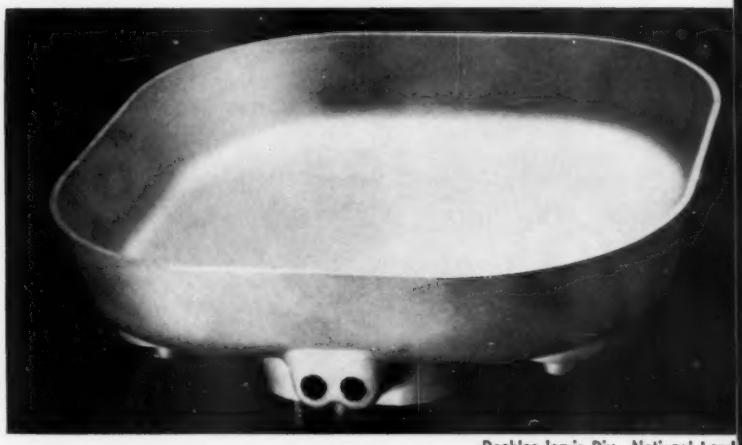
Monarch Aluminum Mfg. Co.

Aluminum 355 permanent mold casting meets physical strength requirements

When this economical new concept in a cast aluminum secretarial chair was designed, the specification for the seat and back support unit called for 319 aluminum alloy. This is a relatively low-cost, non-heat-treated alloy. Subsequent testing under maximum bending loads indicated that the strength was marginal. Before production began an alloy change was made from 319 to 355 in the as-cast state. This alloy satisfied the physical strength requirements needed to pass the bending tests.

Die cast A360 conducts heat well, resists corrosion

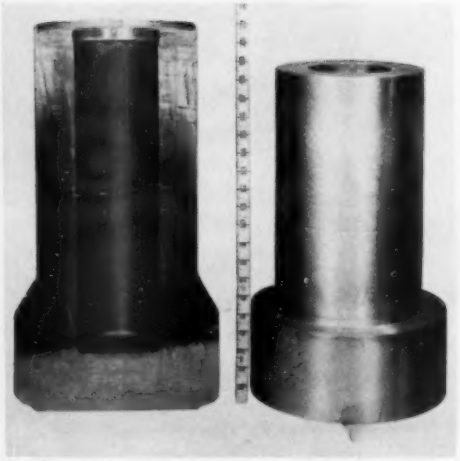
Design requirements for this die cast fry pan called for high thermal conductivity and corrosion resistance. That's why A360 aluminum alloy was specified. Besides being a good general purpose die casting alloy, A360 has very good corrosion resistance and a thermal conductivity higher than most other alloys.



Doehler-Jarvis Div., National Lead

Aluminum bronze impact extrusion has good mechanical properties

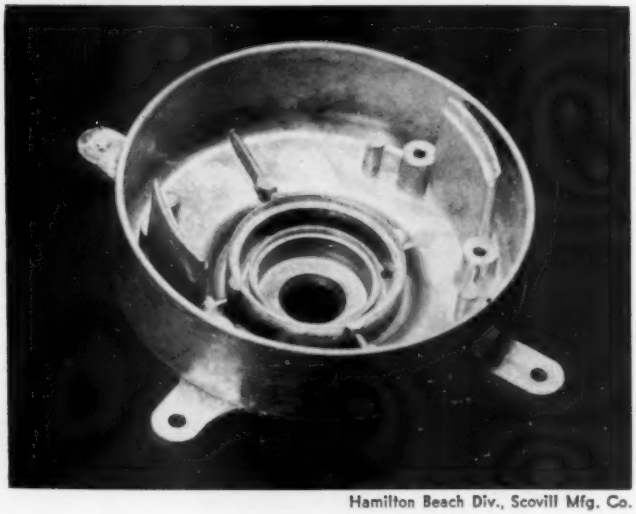
This piston is used in a valve which operates under high pressure. To achieve high mechanical properties it was impact extruded from an aluminum bronze alloy containing 5% nickel. The sectioned part on the left is as-impacted and will be heat treated for maximum properties. The part on the right has been machined to final size. Besides high mechanical properties, impact extrusions eliminate porosity, and allow design flexibility. Other benefits are excellent grain refinement, close dimensional tolerances, reduced machining, and high production rates.



Janney Cylinder Co.

Close tolerances held with die cast zinc

An as-cast dimension of +0.003, −0.000 is held for this motor end cap die cast in #3 zinc (AG40A). The cap aligns a fan and vacuum stream baffles in a vacuum-type floor cleaner. It would have needed much machining to insure proper register if it had been cast in any alloy except zinc. The only machining required for the zinc die casting is the tapping of four holes. The ductility of zinc is another advantage. It permits a stamped bearing mount to be staked into the cap. Any other die cast alloy probably would have needed a more complicated fastening method to hold the mount.

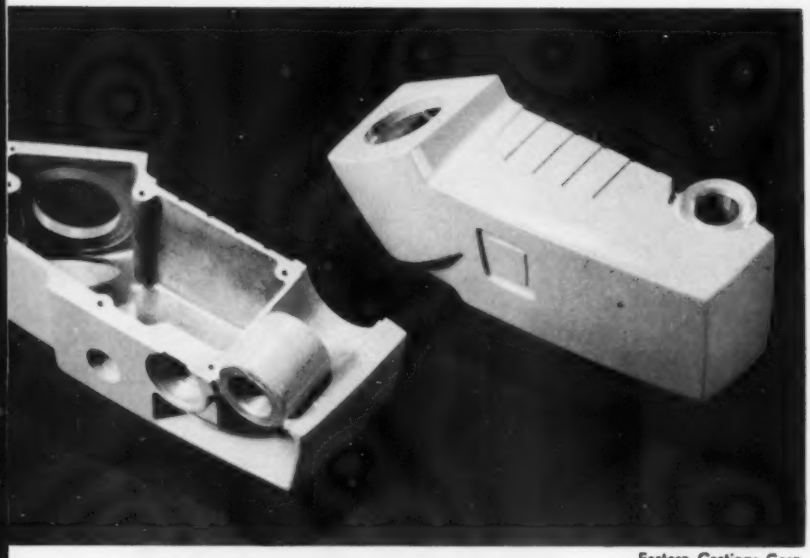


Hamilton Beach Div., Scovill Mfg. Co.

Casting Engineers

Investment cast beryllium copper resists wear, high loads

To assure maximum wear resistance, with high casting fludity, beryllium copper was selected for an investment cast key for a tamper-proof lock. This alloy also resists fracture under high loadings. The key has four flutes to make duplication impossible on conventional key-cutting equipment. The flutes formerly were machined. Now they are investment cast to the same tolerance at a 50% saving.



Eastern Castings Corp.

Die cast A380 needs no polishing prior to enameling

Low finishing cost was one of the big reasons these microscope components were die cast in A380 aluminum. This alloy provides an as-cast hardware finish that needs no polishing prior to the application of a smooth glossy coat of enamel. The good mechanical properties and casting characteristics of A380 let the designers use thin walls and webs to build strong, rigid sections essential for the components in a quality optical instrument.

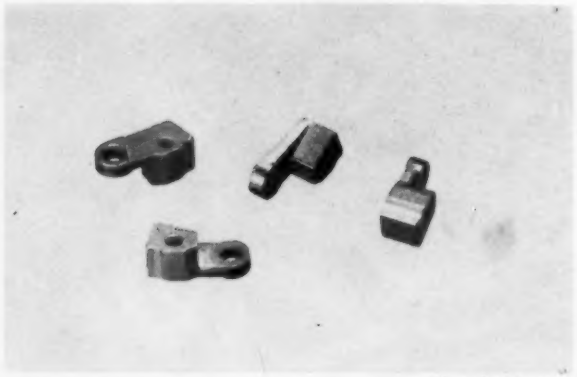
Eaton Mfg. Co.

Infiltrated steel powdered metal part takes heavy impact loads

The driving dog for a two-speed clutch for an automatic washing machine takes heavy impact loads when the dog engages and picks up the full load of the washing machine. Regular metal powders did not withstand the impact or the resulting wear on the end lugs. But an IF-2 iron-carbon-copper infiltrated steel alloy, proper part design, and special processing procedures produced a part with outstanding performance and low cost.

Stainless steel powdered metal part has strength, corrosion resistance

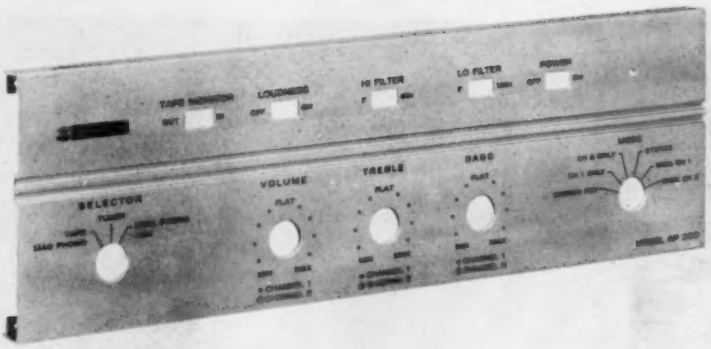
Prealloyed type 316 stainless steel was selected for the powdered metal positioning element in a camera. This material supplied high strength and toughness to withstand repeated jamming action occurring when the camera is opened. It has enough strength and ductility to withstand the press fit of a pin in one hole. Corrosion resistance is sufficient to prevent a change in appearance or function when exposed to a wide variety of atmospheric conditions, including marine salt air.



Dixon Sintaloy Inc.

Extruded 6563 aluminum has good anodized appearance

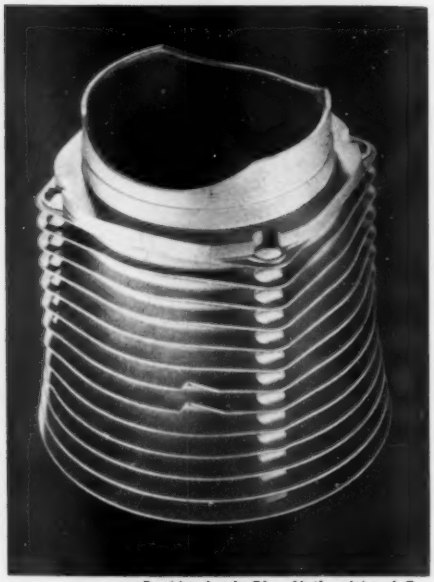
This face for a stereo unit control panel is made from a 6563 aluminum extrusion. This alloy is used where finish is important, particularly after anodizing. Anodizing brings out a bright chromium-like appearance. The extrusion illustrated is gold anodized. Control information is lithographed on the surface in two colors.



General Extrusions,

A132 aluminum die casting resists high temperature creep

Modern gasoline engines, including most of the smaller ones, use relatively high compression ratios. Therefore, cylinder components are subjected to high temperatures and high stresses. Standard aluminum die casting alloys do not withstand high stresses at elevated temperatures without creep. But this cylinder barrel die cast in A132 aluminum withstands the internal combustion temperatures and stresses satisfactorily. This alloy also has a low coefficient of thermal expansion, reducing the design problems of high temperature applications.

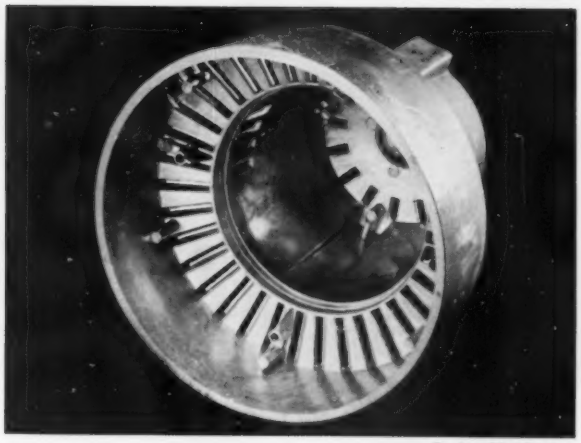


Doehler-Jarvis Div., National Lead Co.

Arwood Corporation

356 aluminum investment castings meet shrinkage requirements

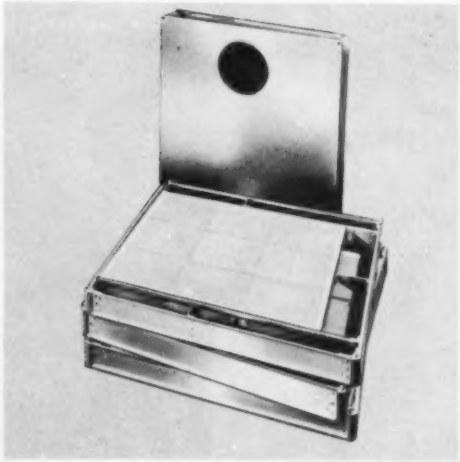
Most of the parts comprising the master handle and the slave end of a master-slave manipulator are investment castings. These manipulators duplicate human hand and finger movements in the remote handling of radioactive substances which are too "hot" for humans to get near. Aluminum was selected because lightness was one of the requirements. Heavy components in the delicate manipulator could not be tolerated. 356 aluminum was chosen to meet all shrinkage requirements.



Racine Die Casting

380 aluminum die casting is light, rigid, economical

The motor housing for a home cleaning appliance had to be light. But the housing incorporates a handle mount, and rigidity requirements narrowed the choice for the housing material to aluminum among the light metals. Aluminum's 10.3 million psi modulus of elasticity keeps the deflections low at the handle mount, eliminating the possibility of the handle loosening. Requirements for appearance and tolerance conformed to conventional industry practice. Therefore, 380 aluminum was selected because it is considered to be one of the best general purpose die casting alloys.



Dow Metal Products Co.

Non-toxic AX31C magnesium extrusions are used for food handling equipment

A gyratory screening unit for the chemical processing and food industries makes extensive use of magnesium extrusions. The reduced weight resulting from the use of magnesium lowers the counter-balancing requirements of the vibratory mechanism. Also, the magnesium parts are easier to handle and disassemble when the unit is cleaned or repaired. AX31C was selected for the extrusions because it offers the best combination of price, strength, non-toxicity, and stability in the presence of food.

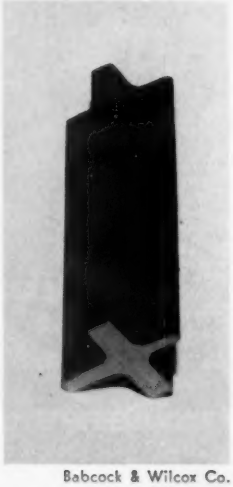
Sintered titanium offers high strength, low weight

A CPT-2A titanium powdered metal part was selected for a jet engine bearing housing for low weight and high strength properties. Low coefficient of thermal expansion assures proper maintenance of alignment over broad temperature ranges. Process and material were also chosen to achieve the desired properties while maintaining reproducible, high dimensional control. CPT-2A has a yield strength of 70,000 psi and an ultimate tensile strength of 85,000 psi.

Clevite Corp.

PH15-7Mo steel extrusions have high tensile strengths

The B-70 bomber has created an unprecedented demand for high performance materials. It will use 350 basic extruded shapes, and between 75 and 80 percent of these will be PH15-7Mo steel. These extrusions have an ultimate tensile strength of 180,000 psi after heat treating. Extruding greatly enhances the properties of the material by aligning the metal grain. If machined from rolled bar stock, the same material would have an ultimate strength of only 100,000 psi after heat treating. PH15-7Mo is easily formed but it can be hardened to high strength levels by simple heat treatment. Where limited ductility or workability are permissible, it can be hardened to an ultimate tensile strength of 265,000 psi.

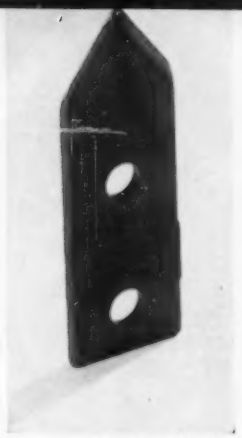


Babcock & Wilcox Co.

Zinc die casting has 100% thread alignment across parting line

The #3 zinc die cast bushing on the left replaces the screw machine part and stamping shown next to it. The 32 pitch full thread on the bushing is cast to class 2 thread tolerances with a requirement of 100% thread alignment across the parting line. The ⅜" hole in the bushing has a tolerance of ±0.001", allowing only one degree draft on the taper pin.

Dowst Mf. Co.



Hitchiner Mfg. Co.

Steel investment casting extends tool life

The cutting blade for a commercial can opener was stamped from 1010 steel. The first investment castings for the blade were made from SAE D-2, an air-hardening, high chromium and high carbon tool steel vastly superior to the stamped part. However, continued development with the alloy produced a modified D-2 which, although it has increased the cost of the blade 100% over the original stamping, it adds 400% to the tool life.

Monarch Aluminum Mfg. Co.

A356-T6 permanent mold castings meet high strength specs

An edict from the U.S. Bureau of Roads demanded that aluminum bridge rail posts used in the Federal Highway Program conform more closely to the properties of the massive steel and concrete railings commonly used. Therefore, the 356-T6 alloy formerly used for the permanent mold cast posts has been replaced by A356-T6. The decrease in the iron content from 0.6% to 0.1% has increased the ductility of the casting by improving the minimum elongation from 3%-5% to 10% in test bars machined from the casting.

Ohio Precision Casting Co.

356-T6 aluminum plaster mold casting meets aircraft standards

356-T6 aluminum was selected for this plaster mold casting because of its high silicon content. This contributes to good casting characteristics, particularly advantageous with thin sections. The alloy also maintains high strength after heat treating. The casting is a mount for an aircraft electrical control device, called an intervalometer. The mounts are highly loaded with both steady and vibratory loads. The castings are sound enough to eliminate the need for X-ray inspection.

F132 aluminum die casting has high hot hardness

The aluminum driving torus for an automobile automatic transmission mates with parts made of steel. These steel parts tend to indent the soft surface of the standard aluminum alloys at elevated temperatures. By die casting the torus in F132 aluminum the hot hardness is increased to a point where indentation no longer takes place. F132 contains 1% Mg, 3% Cu, and 9.5% Si.

Doehler-Jarvis Div., National Lead Co.

Cobalt-base investment casting replaces human hip joints

This investment casting replaces fractured human hip joints. It is cast from a cobalt-base alloy (AMS 5385) equivalent to Stellite 21, a material often used for jet engine blades. Alloy requirements were severe. The part must be impervious to body chemicals, exhibit uniform grain structure and high density, and pass 100% X-ray and zyglo inspection. The alloy selected is virtually impossible to machine, particularly in the intricate configuration of this part. Investment casting was the only economical method of fabrication. The as-cast surface normally requires only light polishing before final use.

Casting Engin

Zinc die casting held to extremely close tolerances

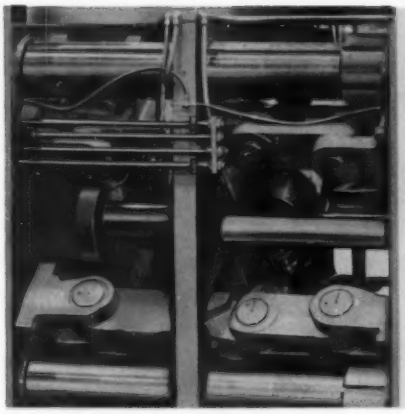
A motor end plate die cast in #3 zinc alloy is held to extremely close tolerances, and at an economical piece cost. The inside diameter is cast to 0.2495" +0.0005, -0.0000. The outside diameter is cast to 0.3750" ±0.0003. Concentricity between these dimensions is 0.0005". The part would be almost impossible to machine to these tolerances, a situation quite unusual for die cast parts. Of course, tolerances like these are unattainable in any die cast metal except zinc.

Peasley Products, Inc.

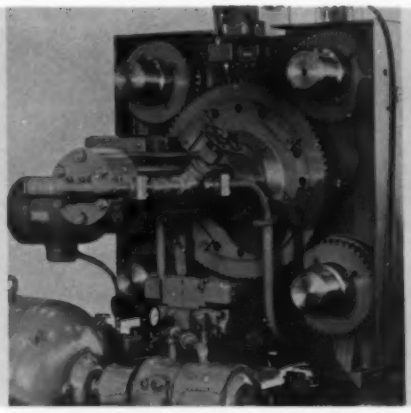
GREENLEE - B & T

DIE CASTING MACHINES

HOT AND COLD CHAMBER, 125 TONS TO 1000 TONS



FOUR-CORNER LOCK-UP



MOTORIZED DIE HEIGHT ADJUSTMENT

SUPERIOR HYDRAULIC SYSTEM

- *High-Speed Operation*
- *Top-Quality Production*
- *Many Design Advantages*

The number of Greenlee - B & T Die Casting Machines in use increases steadily each year. This is convincing proof that Greenlee - B & T builds the kind of a machine that cost-conscious, production-minded die casters need and want.

The Greenlee - B & T four-corner lock-up helps give you greater holding power, best die alignment and lower maintenance. Only Greenlee - B & T offers this unique, toggle locking mechanism.

With the Greenlee - B & T motorized die height adjustment you can adjust for set-up or tonnage control at the touch of a button. Provides easier control without sacrificing rigidity.

A superior, extra-quality hydraulic system is standard equipment on Greenlee - B & T Die Casting Machines. It meets J.I.C. specifications, minimizes leakage losses and reduces maintenance.

Other Greenlee - B & T design advantages include two stage, variable-speed shot control, large hydraulic shot lines and automatic operation.

GREENLEE

B&T MACHINERY COMPANY

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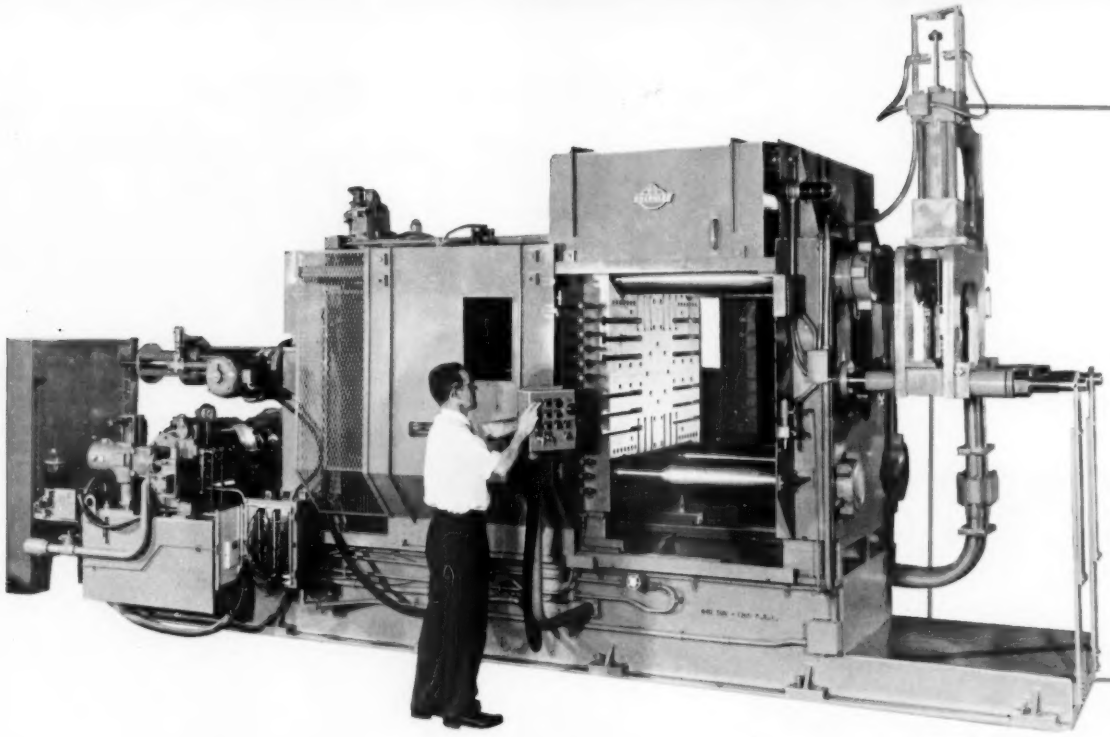
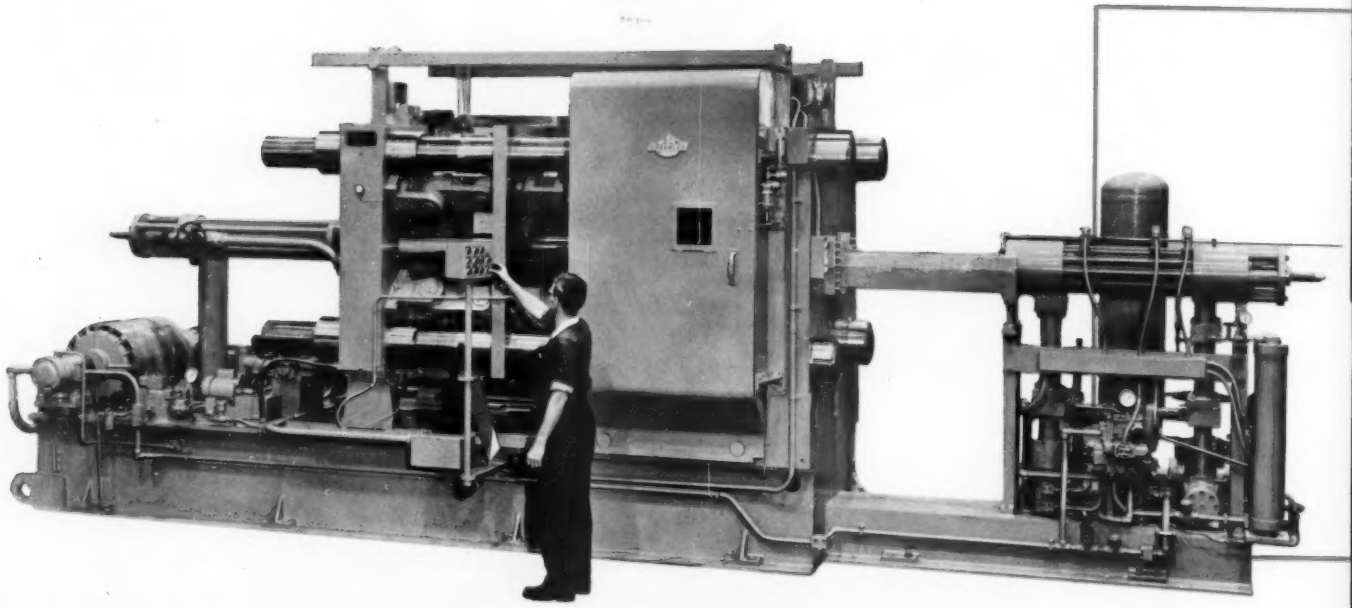




STANDARD OPTIONAL EQUIPMENT

	Aluminum	Zinc
Motorized die height adjustment	X	X
Hydraulic cylinder ejection	X	X
Hydraulic bumper plate ejection	X	X
Core pull valves and electrics	X	X
Hydraulic seals for special fluids	X	X
Automatic machine lubrication	X	X
Thermobulb oil temperature control	X	X

	Aluminum	Zinc
Safety ratchet bar — clamp	X	X
Safety doors and hoods	X	X
Safety block — clamp	X	X
Metal walls and tips	X	
Saddle type die support	X	X
Special filters	X	X
Furnace controls		X

Your special requirements may be met by special machines, circuits, or design features. Please write stating your special problem.

GREENLEE-B&T HOT CHAMBER MACHINE SPECIFICATIONS (ZINC)

TONNAGE	125	250	400	500	600	800	900	1000*
Tie Bar Centers	17 x 17	23 x 23	28½ x 28½	31 x 31	35 x 35	41 x 41	43½ x 43½	48 x 48
Tie Bar Diameter	2½"	4"	5"	5½"	6"	7"	7½"	8"
Front & Back Plates Thick	4"	5"	7"	8"	9"	10"	11"	12"
Front & Back Plates H & V	22 x 21	31 x 31	37 x 38	42 x 42	47 x 48	56 x 56	58 x 58	64 x 64
Movable Plate Thick	4"	5"	6"	7"	8"	10"	11"	12"
Movable Plate H & V	22 x 21	31 x 31	37 x 38	42 x 42	47 x 48	56 x 56	58 x 58	64 x 64
Die Thickness	6" - 16"	10" - 22"	10" - 26"	12" - 30"	12" - 32"	16" - 36"	20" - 40"	20" - 40"
Die Stroke	8"	10"	13"	14"	12" - 17"	14½" - 19½"	17" - 22"	19" - 25"
Shot Cylinder Dia.	2½"	4"	4½"	5"	5"	5"	5½"	6"
Shot Cylinder Stroke	6"	8"	8"	8"	9"	9"	9" Opt. 14"	14"
Horsepower — RPM	15 x 1200	20 x 1200	30 x 1800	30 x 1800	40 x 1200	40 x 1200	50 x 1200	50 x 1200
Machine Size — Width	4'0"	5'6"	7'0"	7'9"	8'0"	8'0"	8'0"	8'9"
Machine Size — Length	11'8"	15'6"	17'0"	18'6"	20'6"	22'0"	23'0"	26'6"
Machine Size — Height	8'0"	7'9"	8'0"	8'6"	10'2"	11'0"	11'6"	12'2"
Machine Weight, Lbs.	10,500	21,000	30,000	33,500	45,500	62,500	67,000	83,000

GREENLEE-B&T COLD CHAMBER MACHINE SPECIFICATIONS (ALUMINUM)

TONNAGE	125	250	400	500	600	800	900	1000*
Tie Bar Centers	17 x 17	23 x 23	28½ x 28½	31 x 31	35 x 35	41 x 41	43½ x 43½	48 x 48
Tie Bar Diameter	2½"	4"	5"	5½"	6"	7"	7½"	8"
Front & Back Plates Thick	4"	6"	7"	8"	9"	10"	11"	12"
Front & Back Plates H & V	22 x 21	31 x 31	37 x 38	42 x 42	47 x 48	56 x 56	58 x 58	64 x 64
Movable Plate Thick	4"	5"	6"	7"	8"	10"	11"	12"
Movable Plate H & V	22 x 21	31 x 31	37 x 38	42 x 42	47 x 48	56 x 56	58 x 58	64 x 64
Die Thickness	6" - 16"	10 - 22	10 - 26	12 - 30	12 - 32	16 - 36	20 - 40	20 - 40
Die Stroke	8"	10"	13"	14"	12 - 17	14½ - 19½	17 - 22	19 - 25
Shot Cylinder, Dia.	3½"	4½"	5"	5½"	6½"	6½"	6½"	7"
Shot Cylinder, Stroke	12	13	16	18	16 - 21	19 - 24	20 - 25	24 - 30
Horsepower — RPM	20 x 1200	20 x 1200	30 x 1800	30 x 1800	40 x 1200	40 x 1200	50 x 1200	50 x 1200
Machine Size — Width	4'0"	5'6"	7'0"	7'9"	8'0"	8'0"	8'0"	9'9"
Machine Size — Length	12'0"	17'4"	18'6"	20'8"	25'0"	26'6"	28'0"	29'0"
Machine Size — Height	5'6"	5'6"	6'0"	6'6"	8'6"	9'0"	9'0"	10'0"
Machine Weight, Lbs.	11,300	22,500	31,000	34,000	46,500	63,500	68,000	84,500

*LARGER MODELS ON APPLICATION.

MACHINE SPECIFICATIONS MAY BE CHANGED AT THE MANUFACTURERS' DISCRETION

SPECIAL OPTIONAL EQUIPMENT

	Aluminum	Zinc
Fully automatic machines include:	•	X
Die lubricators	X	X
Automatic ejection and safety devices	X	X
Low pressure die close safety	X	X
Special machine base and conveyors	X	X
Variable shot position (when not standard)	X	X
Special shot circuits and intensifiers	X	X
Cylinder return stroke adjustment (standard on 600 ton and larger)	X	X
*Furnaces — gas, oil or electric	X	X
Interchangeable injection ends	X	X
Safety interlock circuits	X	X
Special accumulators	X	X
Machines for central water system	X	X
Greenlee - B & T vacuum system (Parting line — ejector box — metal wall)	X	X
Vacuum system machine circuits	X	X

*Automatic aluminum machines require customer's specification on automatic ladling.

COMPLETE LINE OF GREENLEE-B&T

RAPID-PRESS

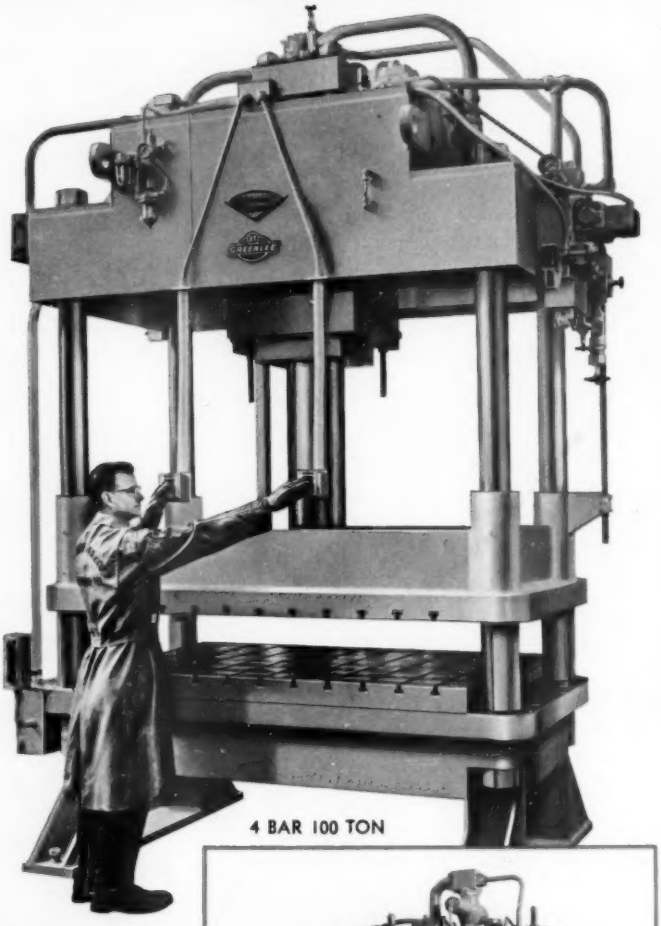
HYDRAULIC TRIM PRESSES

- TWO BAR AND FOUR BAR
- 20 TON TO 100 TON MODELS

Greenlee - B & T Trim Presses handle dies to remove flash from your die castings or plastic parts accurately and economically. The RAPID-PRESS cycle consists of five distinct elements of speed and power:

1 — Rapid Traverse (low pressure, adjustable)
2 — Deceleration Transient (low pressure, adjustable)
3 — Approach Speed (low pressure, adjustable)
4 — Power Stroke
5 — Return Stroke or Pullout Tonnage

The low pressure (20 psi) air-over-oil principle in the reservoir saves valuable production time. Variations in H.P. and speeds, stroke, and daylight are optional with each size press.



4 BAR 100 TON

2 BAR 20 TON

TYPICAL SPECIFICATIONS

	4 BAR 100 TON	2 BAR 20 TON
Horsepower	30	5
Piston Diameter	11½"	5"
Ram Diameter	10½"	4¾"
Pull-out Tonnage	17.3	1.9
Pressure	2000 P.S.I.	2000 P.S.I.
Rapid Traverse Speed	0-1000 I.P.M.	0-1500 I.P.M.
Pressing Speed	59 I.P.M.	70 I.P.M.
Return Speed	850 I.P.M.	725 I.P.M.
Stroke	30" MAX.	12" MAX.
Shut Height	14" MIN. — 44" MAX.	5" MIN — 17" MAX.
Tie Bar Centers	41" x 77"	26"
Between Bars	36" x 72"	23"
Tie Bar Diameters	5"	3"
Traveling Platen	52" x 88"	18" x 31½"
Base Platen	52" x 88"	24" x 38"
Opening In Base Platen	18" x 48"	15" x 18"
Weight	36,000 LBS.	2150 LBS.

STANDARD EQUIPMENT

Extra heavy seamless pipe. Welded flange connections used for pressure piping.

Heat exchanger and magnetic strainer in suction line.

Manifold mounted valves.

Dual operating control buttons for operator safety.

Positive safety stops.

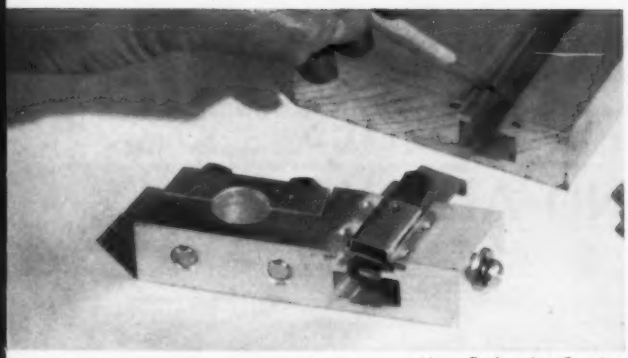
Air pressurized reservoir (20 lbs.) provides rapid advance. Adjustable deceleration valve slows speed on approach to work. Adjustable limit switch cam controls power stroke at required trim position.

Machine arranged to use *hydraulic mineral base oil*, please specify if phosphate-ester base oil or other type oil is used.

Machine is shipped ready to operate after filling hydraulic system and making proper water, air and electric connections.

B&T MACHINERY COMPANY
A DIVISION OF GREENLEE BROS. & CO.
217 W. EIGHTH STREET • HOLLAND, MICHIGAN

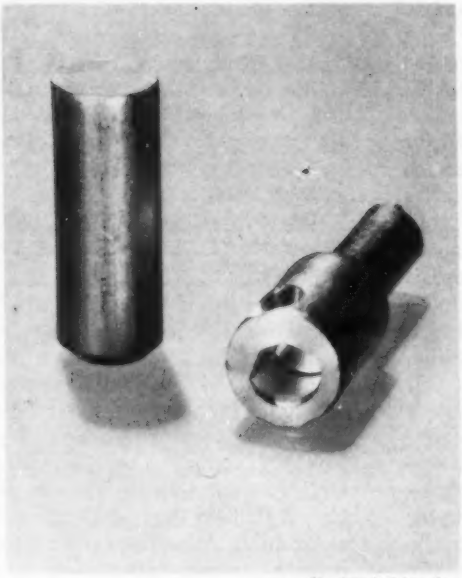
TRANSFER MACHINES • SPECIAL MACHINES • AUTOMATIC BAR MACHINES
WOODWORKING MACHINES AND TOOLS • DIE CASTING MACHINES
TRIM PRESSES • HYDRAULIC AND HAND TOOLS



Howe Engineering Co., Inc.

6063 extruded aluminum has good extrudability, finish, and strength

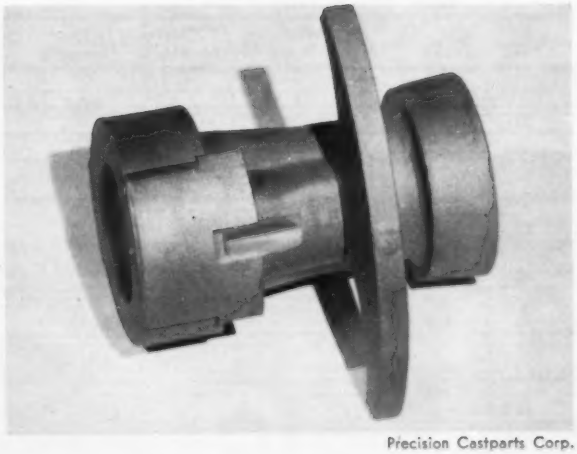
New brush holders for DC motors, generators, and alternators use a main body made from a silver plated 6063 aluminum extrusion. 6063 is a magnesium and silicon alloy which rates as one of the most popular for reasons of extrudability, finish, and mechanical properties. The body for the brush holder (bottom) is cut from the extruded bar (top). The manufacturer says the 6063 extrusion provides corrosion resistance, low costs, and light weight.



Steel Industries, Inc.

Nickel silver impact extrusion approximates properties of steel

The impact extrusion (right) is impacted from the 18% nickel silver slug next to it. The part is a pay telephone adapter. The material was selected to provide mechanical properties approximating those of steel, but with one important additional qualification. It also provides corrosion resistance with no protective surface coating.



Precision Castparts Corp.

Investment cast 17-4PH has good strength-ductility relationship

Not only is it more economical, but this 17-4PH investment casting used in a missile performs with more reliability than the hogged-out part it replaced. 17-4PH is specified where superior corrosion resistance, and relatively high hardness and strength is required. An outstanding characteristic of the alloy is its capability of hardening to Rockwell C40 and above with the use of a low aging temperature. This hardening characteristic means relatively tight flatness, straightness, and concentricity tolerances are available because the material will deform readily in the solution treated state. It also means increased tool life, faster cutting speeds and heavier cuts when machining. After machining, solution treated parts may be hardened without distortion, scaling, decarburization, or cracking.

THE PHYSICAL AND MECHANICAL PROPERTIES OF METALS AND ALLOYS

ANY LISTING of the physical and mechanical properties of metals and alloys formed by the PMM processes must be incomplete.

There is a group of commonly processed alloys, but for special purpose applications there is a very wide range of alloys which may be used, though generally they are more expensive than the standard materials.

In the following tables only the most widely used metals and alloys are listed. Wherever possible, the properties given are from either the ASTM or AISI listings. The properties given are believed to be minimum so that they can be used with utmost safety for design purposes. However, remember that the shape of the part will influence the mechanical properties and sections difficult to cast or form may exhibit properties very different from those listed.

In the case of powdered metal compacts, there is such a bewildering array of powder mixtures to choose from that listings of properties can only be used as a general guide. Compacts of the same composition, pressed and sintered under the same conditions will often have greatly different properties even though the sintered densities are the same. This is because the initial powder used is different, the particle shape varies, the size distribution is not the same, or a mixture of powders (different types of iron powder for example) was used. The properties listed are the minimum given by any manufacturer consulted.

Abbreviations Used

Throughout these tables the following abbreviations and dimensions are used:

Density—values are in grams per cubic centimeter
Thermal Expansion—values in inches per inch per degree F x 10^{-6}
Modulus of Elasticity—in psi x 10^{6}
UTS—ultimate tensile strength in Kpsi
YS-T—yield strength in tension, at 0.2% offset, in Kpsi
Elong.—Elongation in percent in a 2" gage length
BHN—Brinell hardness. Where a letter precedes the hardness number the hardness is Rockwell on the scale noted.
Fatigue Strength—in Kpsi
Shear Strength—in Kpsi
Impact Strength—(I) Izod, (C) Charpy

Sources

Sources of data in these tables include: ASTM Standards 1958 and 1960 supplement; The Alloy Digest; Metal Data by Hoyt; Engineering Materials Handbook by Mantell; Aluminum Co. of America; Reynolds Metals Co.; Kaiser Aluminum & Chemical Sales, Inc.; Keystone Carbon Co.; Amplex Div., Chrysler Corp.; Cadmet Corp.; Vanadium-Alloys Steel Corp.; U. S. Graphite; Dixon Sintaloy, Inc.; New Jersey Zinc Co.; Wakefield Bearing Corp.; Kwikset Powdered Metal Products; Atlantic Casting & Engineering Corp.; and private communications.

Plaster Mold Castings

DESIGNATION		PHYSICAL CONSTANTS			MECHANICAL PROPERTIES						
ASTM	Commercial	Density	Thermal Expansion	Modulus of Elasticity	UTS	YS-T	Elong.	BHN	Fatigue Strength	Shear Strength	Impact Strength
Aluminum											
ZC81A		2.70	13.4	10.3	36	26	5.0	70			
SG70A	356	2.65		10.3	24	12	3.0	70		21	10 (C)
Brass & Bronze											
B146-6C	Yellow Brass #10	8.40	12.0	13-15	40	14	15.0	65			
B149-9D	Aluminum Bronze	7.70	9.0	17	95	40	7.0	190			
B147-8C	Manganese Bronze	7.70	11.0	15.5	115	70	15.0	210			12 (I)
B145-4A	Red Brass	8.80	10.06	13.5	40	17	20.0	60	11		11 (C)
	Beryllium Copper	8.30			80	64	15.0	RC-37			13 (I)

Die Castings

DESIGNATION		PHYSICAL CONSTANTS			MECHANICAL PROPERTIES							
ASTM	Commercial	Density	Thermal Expansion	Modulus of Elasticity	UTS	YS-T	YS-C	Elong.	BHN	Fatigue Strength	Shear Strength	Impact Strength
Aluminum												
G8A	218	2.57	14.3	10.3	45	27	—	8.0	—	23	27	8.3 (C)
S5C	43	2.65	13.4	10.3	33	14	—	9.0	—	17	19	—
SC5	85	2.74	13.1	10.3	40	24	—	2.0	—	22	26	—
S12B, A	13	2.65	12.9	10.3	43	21	—	2.5	—	19	28	—
GZ42A	A214	2.68	14.5	10.3	40	22	—	10.0	—	18	26	—
SG100B	360	2.64	12.7	10.3	47	25	—	3.0	—	19	30	—
SC84B	380	2.72	12.9	10.3	48	24	—	3.0	—	21	31	—
SC84A	A380	2.71	12.6	10.3	47	23	—	4.0	—	20	30	—
SC114A	384	2.70	12.2	10.3	47	25	—	1.0	—	21	30	—
SG100A	A360	2.63	12.7	10.3	46	24	—	5.0	—	18	29	—
Brass												
	Yellow Brass	8.5			58	36	—	6.2	R-45B	—	—	—
	Tombasil	8.3			85	50	—	8.0	B-170	—	—	—
	Nickel Silver	8.45			85	65	—	15.0	B-160	—	—	—
	Silicon Brass	8.6			70	35	—	22.0	B-120	—	—	—
Z30A					45	25	—	10.0	—	—	—	—
ZS331A					58	30	—	15.0	—	—	—	—
ZS144A					90	50	—	25.0	—	—	—	—
Magnesium												
B94-58	AZ-91A	1.81	14.5	6.5	34	23	22	3.0	B-67	14	20	2 (I)
B94-58	AZ-91B	1.81	14.5	6.5	34	23	22	3.0	B-67	14	20	2 (I)
Zinc												
B86-XXIII	3	6.6	15.2	—	41	—	87	10.0	B-82	—	31	43 (C)
B86-XXV	5	6.7	15.2	—	47	—	—	7.0	B-91	—	38	48 (C)

Permanent Mold Castings

DESIGNATION		PHYSICAL CONSTANTS			MECHANICAL PROPERTIES							
ASTM	Commercial	Density	Thermal Expansion	Modulus of Elasticity	UTS	YS-T	YS-C	Elong.	BHN	Fatigue Strength	Shear Strength	Impact Strength
Aluminum												
SSA, B	43-F	2.69	13.4	10.3	23	9	9	10.0	45	—	16	
—	A108-F	2.79	13.3	10.3	28	16	17	2.0	70	—	22	
CS72A	C113-F	2.92	13.3	10.3	30	24	25	1.0	80	9.5	24	
CG100A	122-T52	2.95	13.1	10.3	35	31	31	1.0	100	—	25	
SN122A	A132-T551	2.72	11.6	10.3	36	28	28	0.5	105	13.5	28	
CS104A	138-F	2.95	12.7	10.3	30	24	30	1.5	100	—	24	
CN42A	142-T571	2.81	13.6	10.3	40	34	34	1.0	105	10.5	30	
CS66A	152-T5				32	25						
CS42A	B195-T4	2.80	13.3	10.3	37	19	20	9.0	75	9.5	30	
GZ42A	A214-F	2.68	14.4	10.3	27	16	17	7.0	60	—	22	
GS42A	B214-F				19	13		1.5				
SC51A	355-T51	2.71	13.7	10.3	30	24	24	2.0	75	—	24	
SG70A	356-T6	2.68	13.0	10.3	40	27	27	5.0	90	13	32	
SC122A	T5				32	26						
Magnesium												
AM100A-F		1.81		6.5	22	12	12	2.0	54	10	17	0.6 (C)
-T5		1.81		6.5	40	16	16	4.0		10	21	
AZ91C-F		1.81		6.5	24	14	14	2.0	52	—	18	0.58 (C)
-T6				6.5	40	19	19	4.0	73	—	21	1.0 (C)
AZ92A-F		1.83		6.5	24	14	14	2.0	65	12	19	0.5 (C)
-T6				6.5	40	21	21	2.0	84	12	22	0.8 (C)
AZ63A-F		1.82		6.5	29	14	14	6.0	50	11	18	1.0 (C)
-T6				6.5	40	19	19	5.0	73	11	21	1.1 (C)
EK3A-T6		1.79		6.5	23	16	16	3.0	45		—	
EK41A-T6		1.81		6.5	25	18	18	3.0	50		—	
EZ33A-T5		1.83		6.5	23	15	15	3.0	50		—	

more Tables on pages 63, 65 and 67

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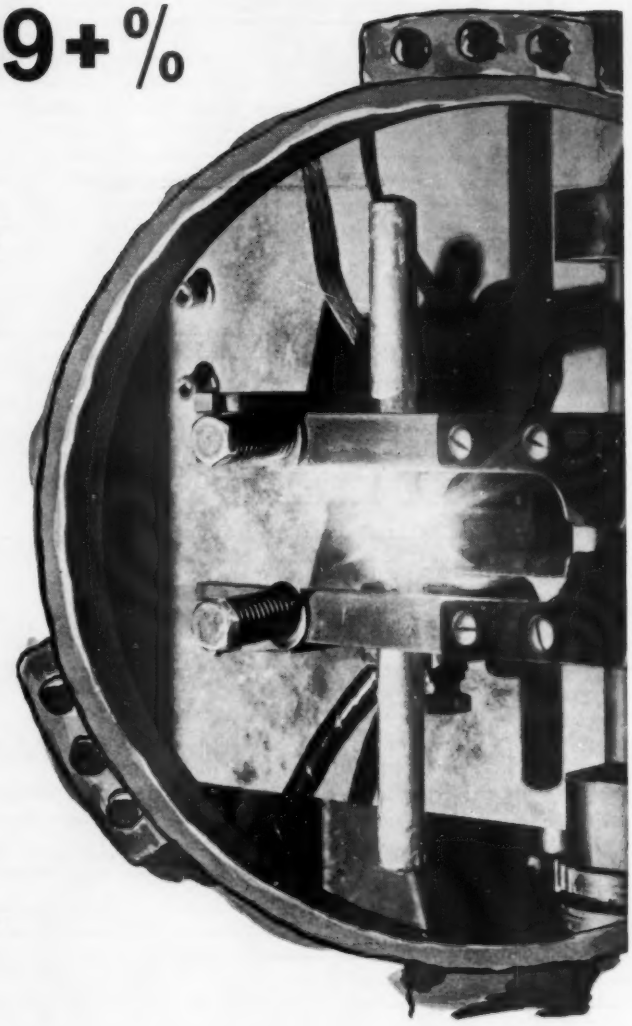

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ZN-130

Extrusions

Commercial Designation	PHYSICAL CONSTANTS Density	Thermal Expansion	Modulus of Elasticity	MECHANICAL PROPERTIES UTS	YS-T	Elong.	BHN	Fatigue Strength	Shear Strength	Impact Strength
FERROUS ALLOYS										
Austenitic Stainless Steels										
AISI 304	8.02	9.2	29.0	77-81	28	57-60	138-152			85 (1)
310	8.02	8.0	30.0	66-70	24-27	54-57	180 max.			80 (1)
316	8.02	9.2	29.0	65-69	25-28	68	200 max.			70 (1)
321	8.02	9.3	29.0	65-67	21-27	63-69	200 max.			70 (1)
347	8.02	9.3	29.0	73-78	28-29	70-74	200 max.			80 (1)
Martensitic Stainless Steels										
410	7.70	5.5	29.0	101	84	23-25	200 max.			85 (1)
410 HT	7.70			151-158	133-135	15-20	120-400			—
418	7.70	5.3	29.0	148	120-123	18	212 max.			60 (1)
418 HT	7.70			203-206	169-178	13-20	120-400			—
431 HT	7.70	5.2	28.0	126-206	104-158	15-21	210-440			—
Carbon & Low Alloy Steels										
1020				60	21-35	34-35	116			
4130				111-116	82-85	21-24	197			
4130 HT				159-165	154-158	12-16	269			
4340				165-168	104-107	12-13	289			
4340 HT				176-178	163-165	12-17	346			
8630				74-79	43-52	28-33	149			
8630 HT				187-199	168-183	7	306			
NON-FERROUS ALLOYS										
Aluminum Base										
2024-0	2.77	12.9	10.3	27	11	22	47	13	18	
2024-T4	2.77	12.9	10.3	68	48	19	120	18	41	
2014-0	2.80	12.9	10.3	27	14	18	45	13	18	
2014-T6	2.80	12.8	10.3	60	70	13	135	18	42	
6063-T42	2.70	13.0	10.3	22	13	20	42	—	14	
6063-T6	2.70	13.0	10.3	35	30	12	73	—	22	
6061-0	2.70	13.1	10.3	18	8	30	30	9	12	
6061-T6	2.70	13.1	10.3	45	41	17	95	13	30	
3003-F	2.73	12.9	10.3	16	6	40	28	7	11	
7075-0	2.80	13.1	10.3	33	15	17	60	—	22	
7075-T6	2.80	13.1	10.3	82	72	11	150	21	49	
Copper Base										
Copper	8.91	9.8	17.0	32	10	55	F40			
Commercial Bronze-Leaded	8.82	11.2	17.0	37	12	45	F55			
Free Cutting Brass	8.49	11.4	14.0	49	18	53	F68			
Muntz Metal	8.38	11.6	15.0	54	21	50	F80			
Naval Brass	8.41	11.8	15.0	57	25	47	B55			
Manganese Bronze	8.35	11.8	15.0	65	30	33	B65			
Architectural Bronze	8.44	11.6	14.0	60	20	30	B65			
13% Nickel Silver	8.72	—	17.0	85	50	20	B83			
10% Nickel Silver	8.72	—	—	81	45	22	B75			
Magnesium Base										
AZ31B-F	1.77			38	28-29	14-15		19	49	
AZ61A-F	1.80			45-46	31-33	15-17		20	60	
AZ80A-F	1.80			49	36	9-12		22	60	
AZ80A-T5	1.80			50-55	38-40	6-9		21	82	
MIA-F	1.76			37-39	—	5-12		—	44	
ZK60A-F	1.83			48-49	36-38	9-14		27	75	
ZK60A-T5	1.83			51-53	42-44	11-14		24	82	

more Tables on pages 65 and 67

STOKES again makes news in powder metal compacting by introducing built-in secondary lower motions for the production of multi-level parts in smaller tonnage presses. With the multiple lower motions built into the press, you don't have to buy expensive special tooling and attachments for each and every part you make. You need make only one basic tool investment—the press.

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Investment Castings

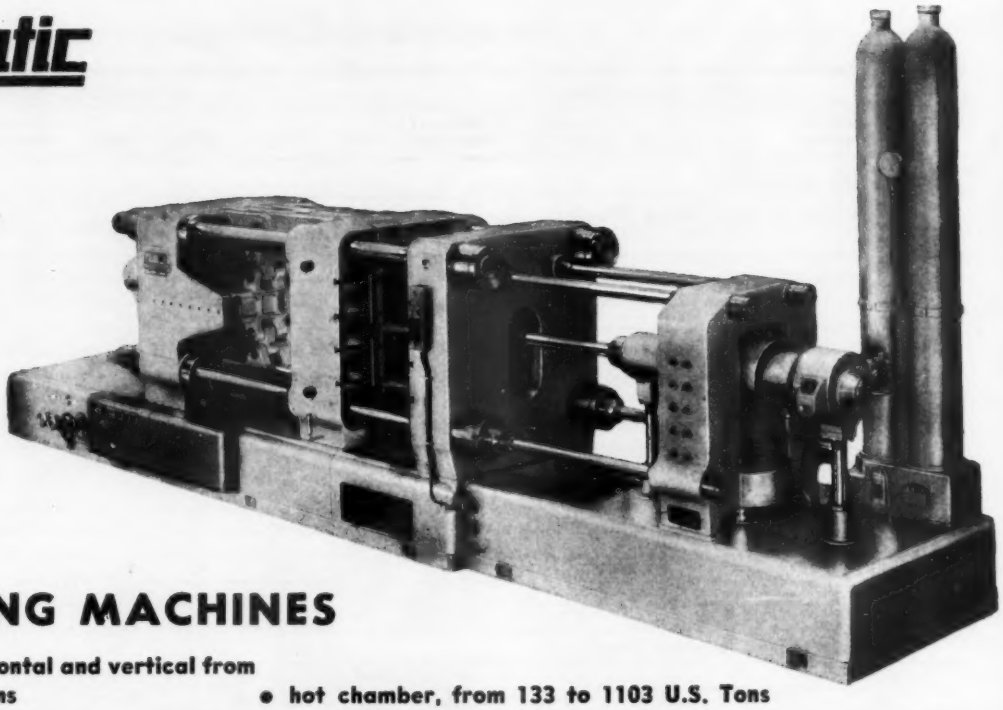
Commercial Designation	PHYSICAL CONSTANTS Density	Thermal Expansion	Modulus of Elasticity	MECHANICAL PROPERTIES UTS	YS-T	Elong.	BHN	Fatigue Strength	Shear Strength	Impact Strength
FERROUS ALLOYS										
Carbon & Low Alloy Steels										
1020			30	60	30	24	150	33		35 (C)
1045			30	80	40	16	170	38		30 (C)
3120			30	70	40	20	146			
8620			30	70	40	20	163			
4130	7.845		30	150	125	9	300	65		14 (C)
4140			30	140-175	110-160	3-8	223-555			
4340			30	175	160	3%	340	77		10 (C)
6150			30	190	175	2	567			
52100			30	190	180	2	400	85		
Austenitic Stainless Steels										
302	7.9	9.2	29	70	30	35	153	34		85 (I)
303	7.9	9.2	29	70	30	30	160			60 (I)
304	7.9	9.2	29	70	30	35	180			85 (I)
310	7.9	8.0	30	75	30	40	180			80 (I)
316	7.9	9.2	29	70	30	35	200			70 (I)
347	7.9	9.2	29	70	30	30	200			80 (I)
Martensitic Stainless Steels										
410	7.9	6.1	29	95-180	75-150	5-3	120-400	58		85 (I)
416	7.9	5.5	29	95-140	50-115	6	180-280	—		—
420	7.9	5.7	29	90-270	50-220	18-2	180-550	—		—
431	7.9	6.5	29	105-220	90-185	25-4	210-440	—		70 (I)
440A	7.9	5.6	29	95-275	55-240	20-2	200-555	—		—
440C	7.9	5.6	29	100-285	60-275	8-1	200-600	—		—
440F	7.9	—	29	100-285	60-275	8-1	200-600	—		—
AM-355				200	150	8	375			
Precipitation Hardening Steel										
17-4PH				180	150	6				
Cobalt Base Alloys										
Stellite 3	8.38			60	—	nil	514			2 (I)
6	8.38	7.7	30.4	110	96	3	444			11 (I)
21	8.30	7.8	16.8	100	80	8		35		2.9 (C)
31	8.61	7.8	36.0	110	80	8	228			
93	7.77			90	—	nil	640			
N-155				100	54	25				
Tantung		7.5		65			555			
Nickel Base Alloys										
Hastelloy C	8.94	6.3	28.0	80	50	10.2	225			40 (I)
Hastelloy X	8.25	7.7		71	44	22.0	165			
S-Monel	8.36	6.8	24.0	100	55	5.0	300	21		6 (C)
Inconel	8.43	6.4	31.0	70	30	10.0		30-35		85 (I)
Inco 713 C				125	110	17.0				
NON-FERROUS ALLOYS										
Aluminum Base										
355-T6	2.71	12.4	10.5	32	20	2.0	80	8.5	28	
356-T6	2.68	11.9	10.3	30	20	3.0	70	7.5	27	
40E	2.80	13.7	10.3	32	22	3.0	75	9.0	26	
43	2.69	12.2	10.3	17	9	3.0	40	6.5	14	
Copper Base										
Silicon Brass				60	26	16.0				
Tin Bronze				40	15	20.0	70			
Yellow Brass	8.47	11.3	15	50	20	20.0				
Yellow Brass Leaded	8.57	12.0	13	40	14	15.0	55			
Red Brass Leaded				30	14	20.0				
Beryllium Copper	8.09	17.0	18.5	150	120	2.0	363	20	90	11 (I)
Manganese Bronze	8.36	11.8	15.0	65	25	20.0	100		42	

Table continued on page 67

castmatic

Model 1000
cold chamber

- oil hydraulic
- automatic
- schedule-preselecting panel



DIE CASTING MACHINES

- **cold chamber, horizontal and vertical from 133 to 2500 U.S. Tons**
- **hot chamber, from 133 to 1103 U.S. Tons**

Characteristics	Mod.	cold chamber — horizontal injection				cold chamber — vertical injection			hot chamber (injection Zn.)		
		150	600	1000	2200	P/150	P/400	P/600	Z/150	Z/400	Z/1000
Clamping force	U.S. Tons	165.4	661.5	1102.5	2425.5	165.4	441	661	165.4	441	1102.5
Die thickness max.	in.	23" 19/32"	35" 7/16"	39" 3/8"	47" 1/4"	23" 19/32"	29" 17/32"	35" 7/16"	25" 19/32"	29" 17/32"	39" 3/8"
Die adjustment	in.	13" 3/4"	19" 11/16"	19" 11/16"	19" 11/16"	13" 3/4"	17" 23/32"	19" 11/16"	13" 3/4"	17" 23/32"	19" 11/16"
Movable platen stroke	in.	11" 13/16"	20" 15/32"	27" 9/16"	59" 1/16"	11" 13/16"	17" 23/32"	20" 15/32"	11" 3/16"	17" 23/32"	27" 9/16"

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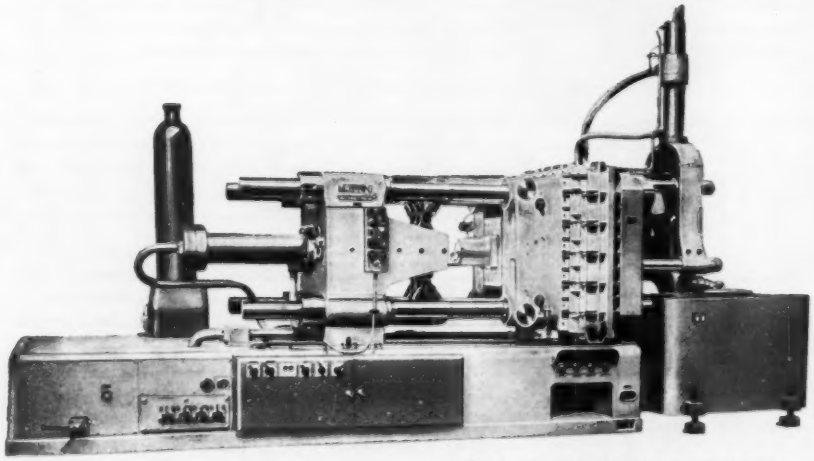

Model Z/400
hot chamber

- oil hydraulic
- schedule-preselecting panel

castmatic

Circle No. 85 on Reader Service Card

Investment Castings (Continued)

Commercial Designation	PHYSICAL CONSTANTS Density	Thermal Expansion	Modulus of Elasticity	MECHANICAL PROPERTIES UTS	YS-T	Elong.	BHN	Fatigue Strength	Shear Strength	Impact Strength
Copper Base (continued)										
High Strength Manganese Bronze			15.0	110	60	12.0	183		47	
Aluminum Bronze	7.5	9.0	18.0	90	45	6.0	155			
Magnesium Base										
AZ92-T6	1.82	14.0	6.5	34	18	1.0	84	12	21	0.8 (C)

Powder Metallurgy Parts

DESIGNATION	COMPOSITION (%) C	Cu	Fe	Ni	Sn	Zn	MECHANICAL PROPERTIES Density	UTS	Elong.	Rockwell Hardness
FERROUS ALLOYS										
			99+				6.2-6.9	13-23	5-8	H37-89
			99+				7.1-7.6	29-42	17-35	E38-72
	1		99				6.1-6.7	26-34	2-3	E47-82
ASTM B 202-60T Type II, Class A		1	99				5.7-6.1	17-23	0.5-1.5	H71-80
		5	95				5.3-5.7	18	0.5	H75
ASTM B 202-60T Type II, Class B		7-11	Bal.				5.6-6.0	27-30	0.5-1.5	H90-94
		7-11	Bal.				6.0-6.4	40	0.5	H95
ASTM B 309-56T Class A	0.15		97.9 min.		(0.25 Si, 0.15 Al, 1.6 others)		6.9-7.3	30	7.0	B50
	0.15		97.9		(0.25 Si, 0.15 Al, 1.6 others)		7.3 min.	37	11.0	B60
AISI 4630	0.30		Bal.	1.7	(Mn.5, Si.25, Mo2.5)		7.3 min.	130	1.5	C30
AISI 4630	0.30		Bal.	1.7	(Mn.5, Si.25, Mo2.5)		6.7-7.1	70	0.5	C25
	1.0	15	79			5	7.3-8.04	73-84	1-3	K85-97
ASTM B 303-58T Class A	0.25	15-25	80		(All others 3.0 max.)		7.1-7.6	65	1.0	
ASTM B 303-58T Class B	0.25-0.60	15-25	70		(All others 3.0 max.)		7.1-7.6	75	1.0	
ASTM B 303-58T Class C	0.60-1.0	15-25	80		(All others 3.0 max.)		7.1-7.6	100	0.5	
STAINLESS STEEL										
Type 302				8	(CR 18)		6.2 min.	50	7.0	B55
Type 304	0.5			10.5	(CR 18.5)		6.3-6.8	29-48	9-19	
Type 316	0.5			13.0	(Cr 17.5, Mo 2.1)		6.3-6.8	30-50	12-22	
NON-FERROUS ALLOYS										
Brass		70				Bal.	7.3-7.6	27	8	H80
		70		(Po.3)		"	7.3-7.6	32	37	H68
		85				"	7.6-7.9	27	12	H74
		90				"	7.6-7.9	22	10	H65
		90		(Po.5)		"	7.6-7.9	29	35	H55
		78.5			(Pb.1.5)	"	7.5-7.8	27	14	H71
		78.5			(Pb 1.5)	"	"	27	12	H81
		78.5		(Po.25)	(Pb 1.5)	"	"	29	24	H71
Nickel Silver		64		18		"	"	33	15	H80
Nickel Silver		70		10		"	"	34	14	H81
Nickel Silver		64		18	(Pb 1.5)	"	"	29	10	H78
	(P 1.3-1.8)	76.3-79.3	—	1.2-1.7	(Pb 1.2-1.7)	"	7.8-8.0	43-48	26-32	BHN 63-70
	(P 1.4-1.9)	77-80	0.25-0.50	2.1-2.6	(Pb 1.1-1.7)	"	7.8-7.95	40-45	16-23	BHN 70-80
ASTM B 202-60T Type I, Class A	1.75 max.	87.5-90.5	1.0 max.		9.5-10.5		6.4-6.8	15	2.5	H-50
ASTM B 202-60T Type I, Class B	1.75 max.	82.6-88.5	1.0 max.	0.35 max.	9.5-10.5	(Pb 2.0-4.0)	6.5-6.9	15	2.5	
		100					7.5-8.3	17-34	6-15	H28-70
		92.0			8.0		6.5-6.8	25	0	
	0.5	92.0			8.0		6.2-6.8	12-16	5.0-5.7	H35-56
		88.0			8.0	(Pb 2.0)	6.8-7.2	19-26	10-13	H54-65
				99			6.7-7.7	18-27	6.6-8.6	H36-87

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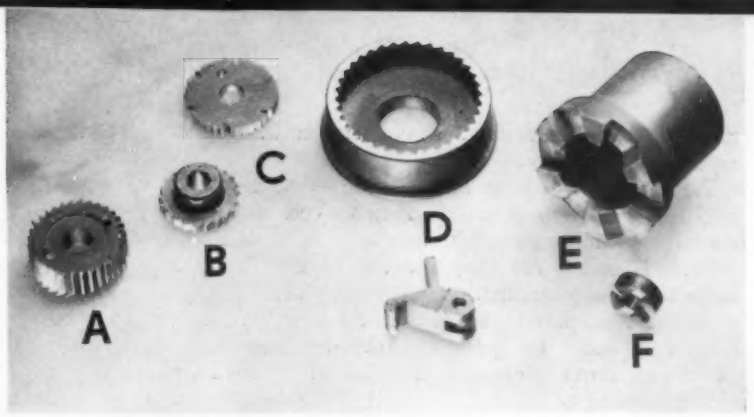

1. TYPICAL RATCHET WHEELS made by powder metallurgy. The unlettered part is a pawl used with the internal ratchet "D".

DESIGNING FOR POWDER METALLURGY

By T. L. ROBINSON, *President, Powdercraft Corp.*

This is the sixth in a series of articles by Mr. Robinson on the design of parts made from metal powders. The previous articles appeared in the May through September issues.

RATCHETS AND PAWLS

MUCH OF THE DESIGN MATERIAL given for gears (see PMM June, July, 1961) can be applied directly to ratchets. Major differences are found in the wear patterns and some of the imposed stresses.

Properly designed gears will have no sliding friction during rotation. The teeth roll on each other. If, therefore, the loading is within the compressive yield strength of the material, there should be no wear on the tooth surfaces.

In contrast, as a ratchet wheel rotates both the pawl, to prevent back motion, and the reciprocating lever slide on the ratchet tooth surface. Even with fairly light loads, as is usual, there can be considerable wear on the tooth surface.

Design differences

As a gear rotates the stresses on the teeth are mostly in bending. By varying tooth design it is possible to compensate for this bending movement so that relatively weak materials can be used.

On ratchets the stresses are almost entirely in compression and shear. Little, if any, change in tooth shape can be made unless the pitch diameter of the rachet wheel can be changed. About the only way to compensate for lower strength in the material is to increase the thickness of the wheel and the pawls.

The standard formula for determining the pitch of a ratchet wheel may be used, but the safe stress is lower for powdered metal parts than for wrought parts. In the formula

$$P = \sqrt{\frac{FM}{LSN}}$$

S is the safe stress. Since for powdered metal parts this is lower than for wrought metal, then L, the length of tooth face or thickness of the ratchet wheel, must be increased if the circular pitch is to remain constant for a given design. When ratchets are to be made from powdered metal, the value of S must be secured from the part vendor before the wheel is designed. All other factors in the design of ratchets will be the same regardless of the material.

Design advantages

Powder metallurgy offers all of the advantages we discussed under gears and cams. Figure 1 shows some typical ratchet wheels and figure 2 illustrates some pawls.

Parts A and B, figure 1, are simple ratchets which could easily be made by standard machining methods. However, through the use of powder metallurgy two recesses are molded in and the two holes cored in part A; four separate operations would be required by normal machining. In part B a large amount of metal is saved which would be removed if the part were machined. Alternately, the hub could be made as a separate piece and fastened by welding, brazing, staking or some other method; again extra operations.

Part C, figure 1, is a special ratchet where every sixth lever operation permits a deeper fall of the follower. Even if the ratchet were cut in the usual

manner the 6 deeper teeth would have to be formed separately.

Part D, figure 1, is an internal ratchet which could only be made as an assembly of two pieces if it were made by ordinary shop methods.

Parts E and F are face ratchets. In both cases a large saving in manufacturing costs is made. The larger of the two, part E, also illustrates how very long hubs can easily be gotten by powder metallurgy. Machining scrap is eliminated as are either separate spacing collars or assembly of parts. The pawls shown in figure 2 are typical of the different shapes possible with powder metallurgy. Where a cross-slot occurs, it is generally put in by milling as a second operation. Since most of the wear and stress is on the engaging or driving face of the pawl, it can be selectively hardened while the balance of the piece is left unhardened. Naturally, if it is desirable, the entire part can be hardened or case hardening may be done.

Generally, a pawl includes a bearing surface where

2. A GROUP of pawls showing the different shapes possible with powder metallurgy.

the high porosity of powdered metal parts is most desirable due to the self lubricating properties if the part is impregnated with oil.

When the engaging or driving face need not be as porous as the balance of the part, local high density may be secured by proper tool design. Localized induction hardening can also be used.

Because pawls will usually have a complex shape, tooling may be more expensive for them than for the more simply shaped ratchets.

Wear-resistance

Other than the intricate shapes possible and the saving in machining, powder metallurgy offers another very distinct advantage. This is self-lubrication of the parts. Non-infiltrated parts can be impregnated with oil to give a constant oil film over the areas where sliding occurs. If both the pawl and ratchet are made of metal powders and both impregnated with oil, even better anti-friction properties are secured.

Accuracy

Ratchets made from powdered metals can be made to the same accuracy as powdered metal gears. Under normal production methods the accuracy is as good as a cut ratchet *when the cutting tools are new*. Deviation will, however, be much less in powder metallurgy than in normal machine shop practice. Many thousands of parts can be made from a set of powder metallurgy tools before measurable wear occurs and runs of 100,000 or more are not uncommon. Milling cutters, on the other hand, will require frequent sharpening to get the same production with all parts in tolerance.

When extreme accuracy is required a shaving operation is required regardless of the method of generation.

Hardenability

Ratchets made from iron powders can be hardened by case carburizing, through carburizing, or infiltration. Strengths up to almost 200,000 psi are possible.

In addition, an infinite number of alloys and mixtures are possible; a condition impossible to secure by normal machine shop methods of manufacture. As in the case of gears and cams, mixtures of immiscible metals, metals and non-metals, and metals and ceramics are possible.

Design disadvantages

The principle disadvantage of ratchets made from metal powders is strength. Normally they should not be used for very heavy loadings and in applications where shock loading may occur. Copper infiltrated parts may, in some cases, be used for these parts.

The safe stress factor is not known for many powder metal mixtures and will vary as the conditions of pressing and sintering vary. It is probable, though, that a value of 1200 psi for moderate shock loading and 2000 psi for non-shock loading are the maximums which should be used for non-infiltrated parts. This would indicate that the value of L, the length of the tooth face should be doubled for powdered metal parts if the ratchet is to be operated at near 100% of the safe load, and if we assume a constant pitch diameter and number of teeth.

Unless production quantities of ratchets are high, initial tooling costs may seem excessive. Tooling for a simple ratchet will probably run from about $500 up.

Another possible disadvantage to powder metallurgy may be size. The practical maximum at this time is about 4 inches in diameter and the thickness should not exceed 2 inches. However, consult your vendor before specifying sizes near the upper limits. Not all vendors have press equipment capable of making the largest sizes and some can make parts considerably larger than 4 inches in diameter.

ADVANTAGES OF POWDER METALLURGY	DISADVANTAGES OF POWDER METALLURGY
Low unit cost	Relatively high tooling costs
Wide choice of materials	
Self lubrication	Somewhat lower strength
Greater accuracy, piece to piece	Considerably lower shock resistance
Replacement of an assembly by one part	
Parts can be hardened for high strength	Relatively small parts are the most practical

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Alumon "D" is easy to make up. One hundred gallons of solution requires addition of only 20 gallons of Alumon "D" Liquid (or 100 lbs. of Alumon "D" Powder) to water, compared with dissolution of 450-500 lbs. of powdered chemicals for a conventional bath. For detailed information, write today to: Enthone Incorporated, 442 Elm Street, New Haven 8, Conn.

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CARBOTROL 7—CARBORUNDUM

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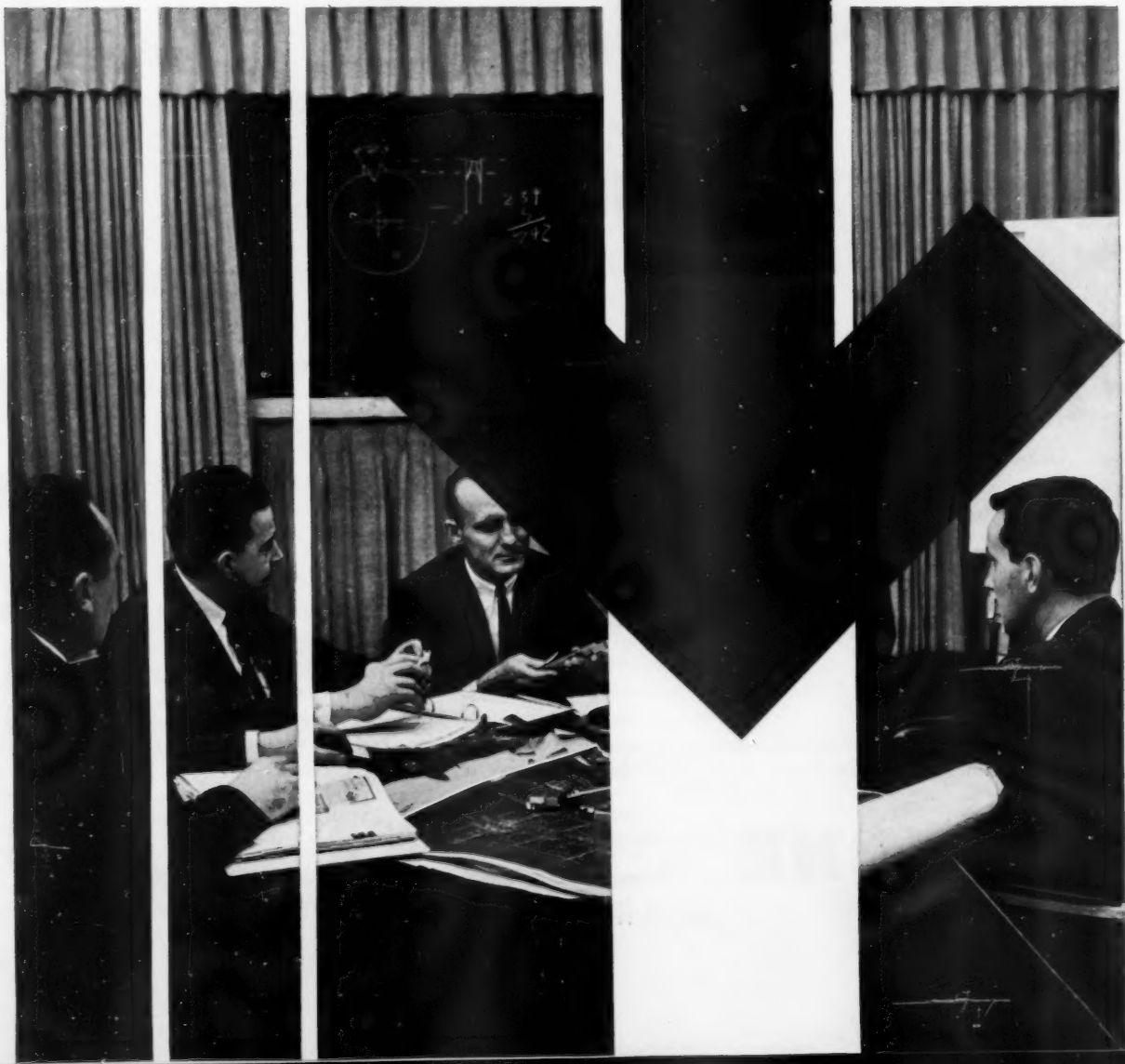


AUTOMOBILE BRIGHT-WORK GETS A NEW LEASE

2 to 5 times greater life for chromium plated zinc die castings

MORE SALT on icy streets, more polluted atmosphere, and more gasoline additives corroded the plated zinc die castings on American automobiles.

The zinc industry could lose a major market unless better chromium plating could be developed. Faced with this challenge, the zinc industry, the die casting industry, and the plating supply companies cooperated in an intensive research and development program. The result is three new plating systems. Today, every American automobile manufacturer uses, or specifies, chromium plating on zinc die castings which will have a useful life of from 2 to 5 times that of older plates.

As a result of this work more zinc die castings than ever before are being used on cars; the average is 75 pounds per standard auto.

The intensive R & D program was started in the summer of 1957. Researchers at Battelle Memorial Institute quickly found that the plating industry, the die casters, and the automobile industry had been working on the problem and had come up with some pretty good answers. The results of the early work were verified by Battelle and the auto industry was urged to adopt one of the processes.

The Old Plating System

The minimum amount of metal deposited in recesses by the plating systems used several years ago is given in Table I. This gave a satisfactory finish for use in rural areas and the smaller urban areas.

TABLE I

PREVIOUS PRACTICES FOR ELECTROPLATING ZINC DIE CASTINGS

	Minimum Thickness of Electroplate in Recesses, in mil	
Electroplate	Method A[a]	Method B
Copper	0.3 to 0.5	0.3 to 0.5
Bright Nickel	0.8[b]	0.8[b]
Chromium	0.01	0.03 to 0.04

[a] Method A was more popular than Method B.

[b] Parts with deep recesses often received less than 0.8 mil of nickel.

Under the air and road conditions which exist today, however, rapid failure occurred. The method of failure was usually:

AFTER THREE YEARS' atmospheric exposure, mirrorlike plated die cast zinc panel is compared with corroded panels by Battelle electrochemist W. H. Safranek.

1. Pit-type corrosion in the nickel plate which began under discontinuities in the chromium plate. These were pores in thin (0.01 to 0.02 mil) chromium, or cracks in thicker (0.03 to 0.05 mil) chromium plate.
2. The copper and nickel plates were perforated at the pit sites as a result of subsequent corrosion.
3. When the copper and nickel became perforated, zinc alloy corroded rapidly in a lateral direction.
4. Bulky zinc corrosion products exerted pressure on the undermined copper, nickel and chromium composite. This raised a blister.

Under adverse conditions, this failure might occur within a very few months after exposure to corrosive environment started.

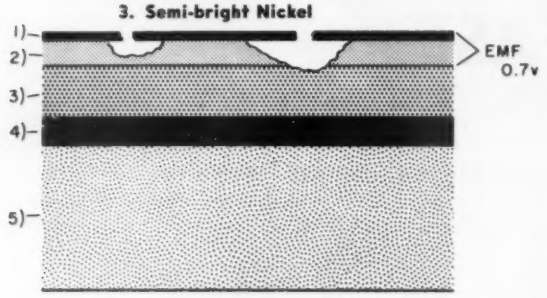
The New Plating System

Three new plating systems have resulted from the research work. These systems are outlined in Table II.

Both outdoor and accelerated corrosion tests (see illustration) showed that these systems would give from 2 to 5 times the useful life as compared with the older plating system. The duplex nickel system gives about double the former life when 0.01 mil of chromium is applied. With 0.05 mil of chromium the

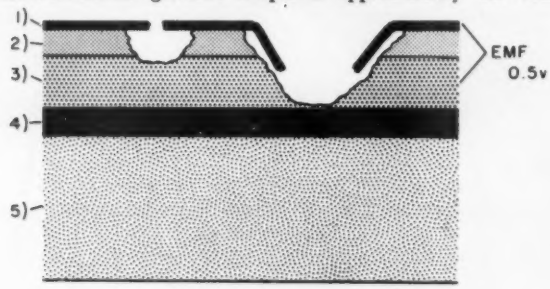
HOW NEW ELECTROPLATES CORRODE

1. Chromium
2. Bright Nickel
3. Semi-bright Nickel
4. Copper
5. Zinc



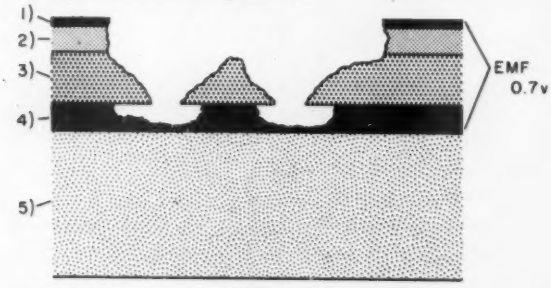
3 MONTHS

Corrosion pitting begins in bright nickel plate under pores and cracks in chromium plate. The nickel is anodic to the chromium. The driving force (electromotive force, EMF) for the nickel-chromium galvanic couple is approximately 0.7 volt.



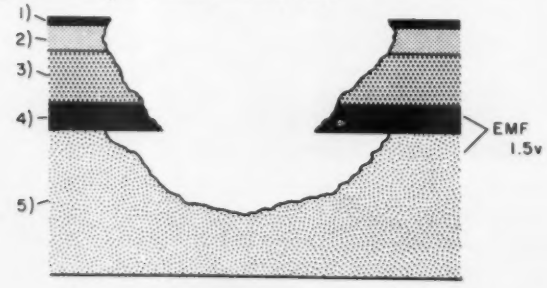
10 MONTHS

Corrosion pitting perforates the bright nickel and enters the semibright layer. The corrosion rate is then somewhat reduced between the driving force (EMF between chromium and semi-bright nickel) is only 0.5 volt.



12 MONTHS

When the semibright nickel is perforated by corrosion, copper begins to corrode. The driving force of the chromium-copper galvanic couple is more than 0.7 volt.



18 MONTHS

After the nickel and copper electroplates are perforated by corrosion, the zinc alloy corrodes rapidly. The electromotive force between zinc and chromium is 2.2 volts.

service life is about five to one. The other two systems should give about a five to one life.

TABLE II
CURRENT PRACTICES FOR ELECTROPLATING ZINC DIE CASTINGS TO BE EMPLOYED ON EXTERIORS OF AUTOMOBILES

Electroplating	Minimum Thickness of Electroplate in Recesses (in mils) Method A (Duplex Nickel)	Method B (Bright Crack-Free Chrom. plus Duplex Nickel)	Method C (Duplex Chrom. over bright Nickel Single Layer)
Copper	0.3	0.3	0.7
Semibright Nickel	0.9	0.6	——
Bright Nickel	0.3	0.2	0.8
Chromium	0.01	0.03*	0.03**

* Crackfree Chromium
** Dual Chromium

Acceptance of the newer plating systems by the automobile companies is shown in Table III.

TABLE III
AUTOMOTIVE INDUSTRY'S USE OF IMPROVED PLATING SYSTEMS FOR EXTERIOR ZINC DIE CASTINGS

FORD MOTOR COMPANY	All of Ford's plated die castings are now supplied by independents and many of these use one of the new, upgraded systems including Duplex Nickel.
	Electric Auto-Lite, an independent which supplies plated die cast zinc parts for Lincoln and Mercury (as well as American Motors, Studebaker, Chrysler), employs a proprietary Duplex Nickel process.
GENERAL MOTORS	At its own installation, Ternstedt Division, uses a Dual-Chromium system.
	G. M. parts supplied by Guide Lamp employ both a proprietary Duplex Nickel system and a high temperature-high ratio crack-free chromium system. Parts supplied by Brown-Lipe-Chapin use essentially the same.
CHRYSLER	Buys all major chromium-plated zinc die castings from independents specify Duplex Nickel entirely (minimum thickness 0.0012").
AMERICAN MOTORS	Buys from independents entirely; calls for Duplex-Nickel. Other systems are accepted if they qualify under acceptance tests.
STUDEBAKER	Buys all parts from independents with stipulation that all parts meet acceptance corrosion tests.

This report prepared by the American Zinc Institute

1 2 3 4 5 6 7 8 9 count to 10

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   Mount more in less space.
6. **Provisions for optional wiring in every instrument**
   For 120, 240 or 208 volts — 50 or 60 cy. Wired from the front.
7. **Interchangeable control modes**
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   Guarded against accidental movement.
10. **Optional instrument housings**
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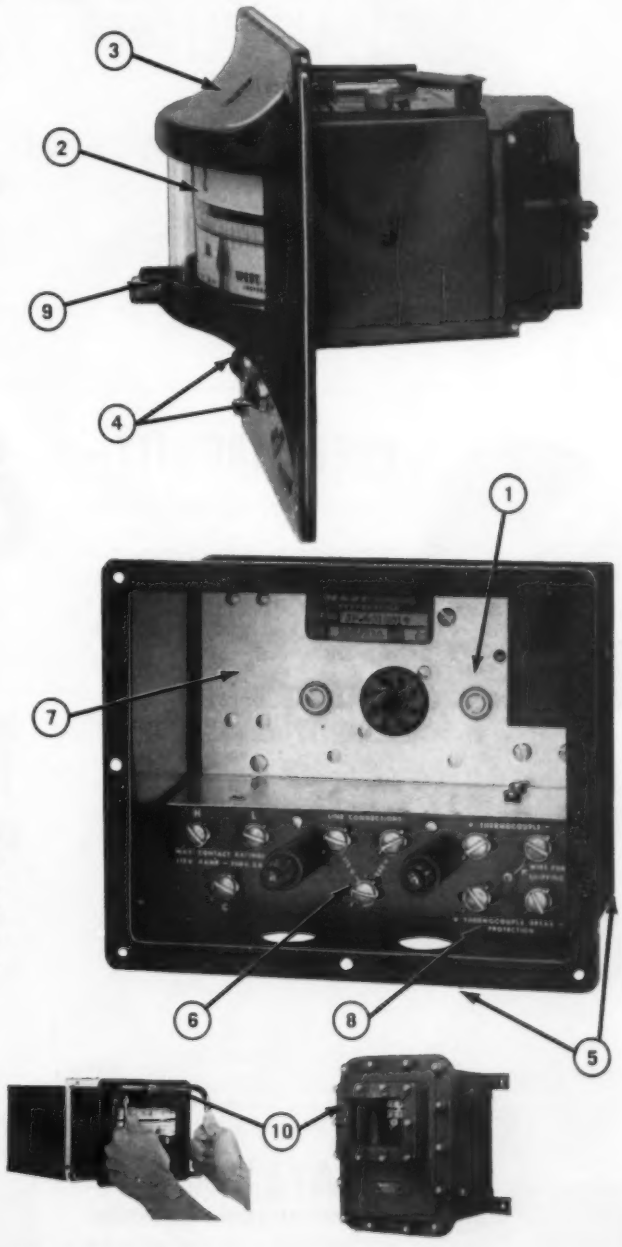

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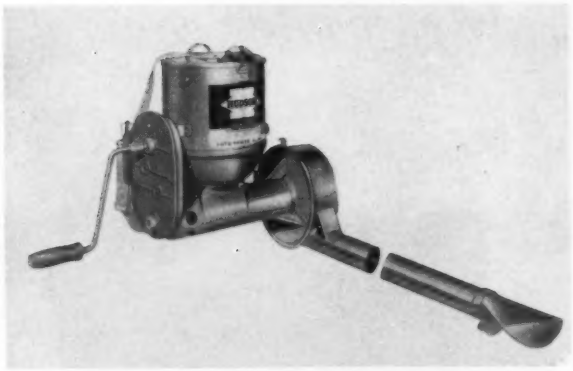
Circle No. 90 on Reader Service Card

Aluminum Die Castings Save Weight

. . . make crop duster easier to carry



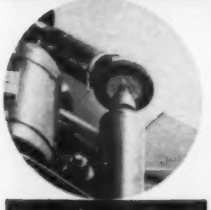
IT'S LIGHTER to carry on your shoulder when many of the parts are made of aluminum. That's why the H. D. Hudson Co. redesigned the crop duster shown. It uses aluminum die castings instead of sand castings.

The housing for the gear-train is cast in two fitted parts. Clearance between the two parts is so close that no grease leaks out nor does any dust get in.

Other parts of the duster which were converted to die castings are the hopper pad which feeds air to the blower fan, the feed-out chamber of the fan, and a tube for dispersing the insecticide.

All of these parts show a marked saving in manufacturing cost due to reduced machining. They could be made lighter because wall thicknesses are less when die cast than when sand cast. Finally, where added strength or rigidity is needed the die cast parts can be ribbed easily.

Cleaning and polishing small component parts, instruments and control mechanisms.



Breaking edges, shaping to slight radius, touching-up and scores of other operations.

Relieving stress concentration and blending-in to reduce danger of fatigue failure.

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HORIZONTAL BARREL AND VIBRATORY FINISHING

. . . each has its advantages

By **GENE OLSON,** *Manager, Almco Queen Products Div., King-Seeley Thermos Co.*

Horizontal rotating barrel and vibratory finishing machines each have a job to do. Neither is a cure-all for mechanical finishing problems. Which machine is better depends on the size of the part to be finished, its shape, and the finish wanted.

This is the essence of recommendations made to the Kiowa Corporation by Almco Queen Products Division, a manufacturer of barrel and vibratory finishing equipment. Kiowa, a custom die caster, offers surface finishing services. When the company decided to install a bulk finishing department, they called in engineers from Almco for recommendations.

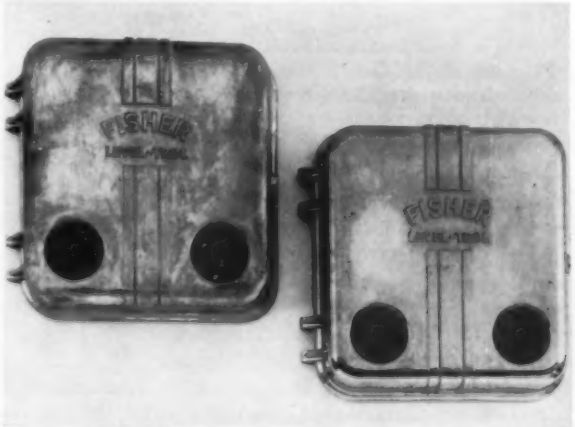
Functional requirements

Appearance is not important for many of Kiowa's castings. Often the requirements are only to remove heat check marks, blend parting lines, and prepare the surface for painting. For this work Almco recommended vibratory finishing.

Media in a vibratory tub creates a constant scrubbing action because it's all active. This scrubbing quickly deburrs parts to a dull satin finish, especially when using various types of aluminum oxide media. Burrs, flash, and heat check marks disappear rapidly. The resulting surface is a good base for paint. Although vibratory finishing produces general surface improvement, it is easier to produce a highly lustrous surface by barrel finishing (more on this later).

Almco recommended vibratory finishing for the following typical parts. All of these parts need only rapid cutdown of metal and general surface improvement, not high luster.

All flash must come off of the instrument housing, figure 1. Any small metal scraps left in the casting might work in the delicate instruments it shields. Vibratory finishing is the fastest way to remove the flash.

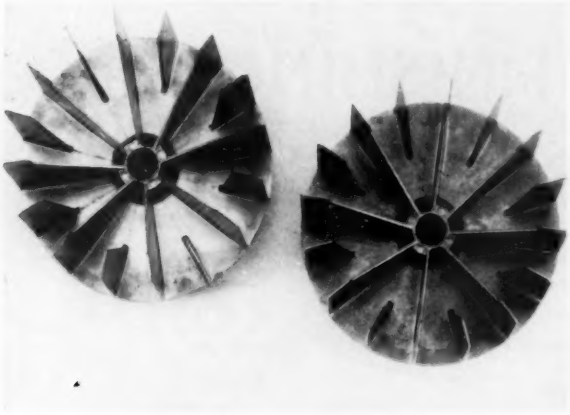


1. Instrument housing was vibratory finished to remove flash and generally improve surface. Finished housing is on the right.

An impeller, figure 2, blows hot air through a clothes dryer. The impeller's blade edges need deflashing and radiusing so they will not collect lint. Vibratory finishing removes flash, blends parting lines, removes heat check marks, and saves 78% over hand finishing.

The computing machine card filer, figure 3, used to be hand finished, a tedious and expensive process. Even so, the uniformity and quality of hand finishing do not measure up to vibratory results.

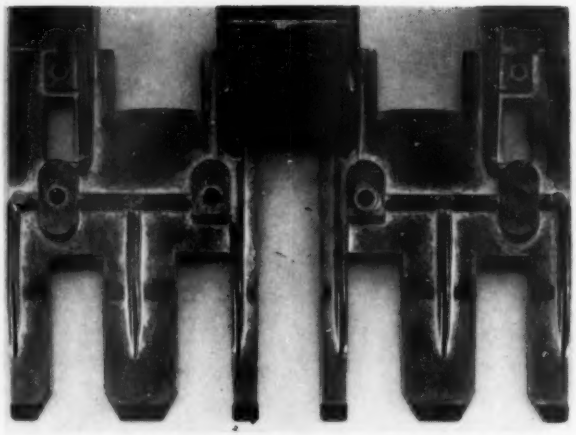
A grill for a lawnmower, figure 4, needs only three minutes in a vibratory machine to prepare the surface for one-coat painting. Hand finishing would be very costly and difficult to accomplish.



2. Impeller blades were vibratory finished to remove sharp edges, remove parting lines (top) and blend heat check marks (bottom). Finished parts are on the right.

Sometimes it is better to finish large, heavy parts in a vibratory machine. In a horizontal barrel it is easier for such parts to impinge. Parts placed in a vibratory machine tend to remain in their respective positions. Therefore, there is less chance for part-to-part contact and resulting impingement.

Twenty-seven of the 7-inch impellers, figure 2, can be finished at one time in a vibratory machine. In a barrel these parts would require special fixtures to prevent impingement. This would make loading and unloading very time consuming.



3. Card filer for computer is vibratory finished to remove flash from edges of fingers.

Appearance requirements

Where appearance was important, Almco recommended finishing smaller parts in horizontal barrels. The finishing action in a barrel depends on a sliding layer of parts and media about two inches thick. The depth of this sliding layer depends upon barrel speed. This gentle sliding action and the use of cushioning type compounds produce a burnished or lustrous satin surface with very good appearance.

The parts in figure 5 belong to a window frame assembly. Both are visible in the final assembly, so they were barrel finished to produce a superior metal tone.

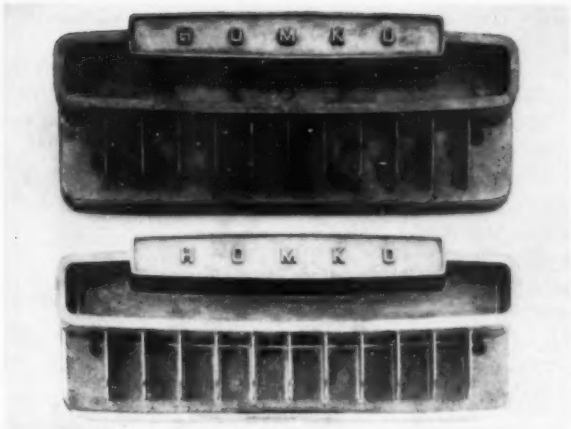
A hanger for a screen door, figure 6, is barrel finished to provide a lustrous appearance. The finishing cost for this part is very low.

Vibratory machines can turn out exceptionally good surface finishes if loaded with less aggressive media. Plastic particles, wood balls, and steel shapes are some of the media that produce lustrous surfaces with vibratory machines. However, expect longer finishing times and lower production when using a vibratory machine to approximate barrel finishes.

Some parts require both

The rectangular slot in the lower part in figure 5 must be held to $\pm 0.002''$. Flash around the slot must be removed and the parting line blended. The tolerance was difficult to hold when the flash was removed by filing. Vibratory finishing easily blends the parting line, removes the flash, and holds the tolerance. As mentioned earlier, the part is also barrel finished to provide luster. Hand finishing cost thirty times more than the combined barrel and vibratory finishing, yet results weren't as good.

The part also illustrates another advantage common to both barrel and vibratory finishing – uniformity. The controlled media action gives all parts the same treatment. Therefore, all are uniformly deburred or conditioned. Hand work gives irregular results unless done with extreme care.



4. Three-minute cycle in a vibratory machine prepares unfinished grill (top) for one-coat painting.

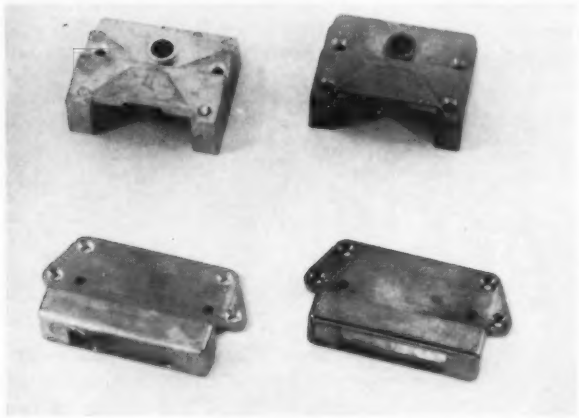
Other considerations

Vibratory machines can provide savings when any of these factors are present:

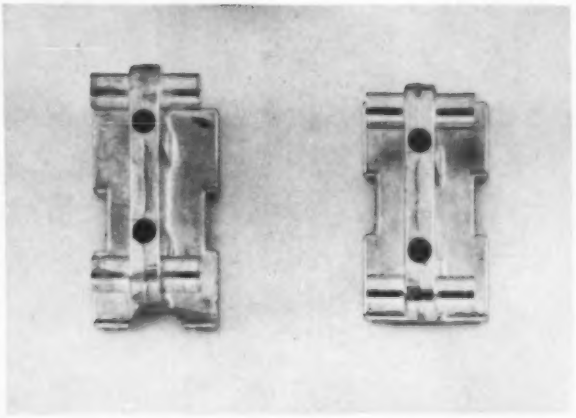
- Large production requirements.
- A wide variety of finishing requirements.
- Floor space limitations (fewer machines are needed for quantity production).

This, however, concerns floor space and capital expenditure only. Labor costs for loading, unloading, rinsing, and separating remain about the same for both vibratory and horizontal barrel machines.

A vibratory machine costs about twice as much as a horizontal barrel with similar capacity. But a vibratory machine commonly finishes many times more parts.



5. Barrel and vibratory finishing removed flash on window frame parts. Finished parts are on the right.



6. Screen door hanger was barrel finished to a high luster. Finished part is on the right.

BRIEF COMPARISON OF VIBRATORY BARREL FINISHING

	Vibratory Finishing	Barrel Finishing
Characteristics	Produces rapid metal cut-down, particularly with highly abrasive media. Easily reaches recesses, holes, and shielded areas. Media acts on parts with more of a scrubbing or direct attack action. Can produce very good surfaces by use of special media and techniques.	Easily produces lustrous surfaces with excellent appearance. Rate of metal cut-down is slower than with vibratory machines. Has more difficulty reaching shielded areas. Finishing action is mostly a sliding or honing action.
Applications	Rapid removal of flash, heat check marks, burrs. Produces general surface improvement.	Providing lustrous surfaces for parts requiring exceedingly good appearance. Removal of burrs and flash from parts without shielded areas, or where rate of production does not require the faster, more expensive vibratory equipment.
Production Rate	Several times faster than barrel finishing on applicable parts.	Production is much greater than with hand finishing, but lower than with vibratory finishing.
Costs	Equipment, maintenance, and media costs are higher than for horizontal barrel machines, but usually paid for quickly by savings in finishing costs.	Equipment and media costs are substantially lower than those incurred with vibratory equipment.

new products & developments

Continued from page 26

One-application impregnating material

FREDRICK B. STEVENS, INC.—Stevens X-100 Impregnator is designed to give nearly 100% casting recovery with only one application in cases where two or three applications were previously used. The new product contains fillers equal in dimension to the porosity in porous castings. These fillers, like the porosity, progressively increase in quantity as they decrease in size from a comparative few at .0016 inch down to a large quantity at .000004 inch. The fillers are inert and will not stain metal.

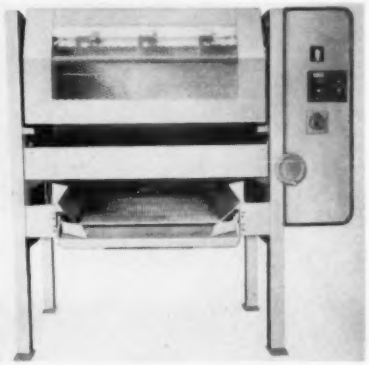
Test data indicates that this product greatly improves sealing of castings impregnated by pressure autoclave, vacuum-pressure autoclave, long-period immersion at atmospheric pressure, and combined pressure sealing and testing.

These tests of the new Stevens impregnator were made extensively on both large and small castings made of a variety of metals.

Circle No. **245** on Reader Service Card

Combined barrel finishing and screen separating machine

RAMPE MANUFACTURING CO.—Power-driven screen separating and high-speed operation are features in this machine for deburring, micro-finishing, and similar processes. Hand separating of parts and media is eliminated, providing increased machine output.



These "Combine" Models are available in 4 to 20.7 cu. ft. barrel capacities, with a selection of one to four compartments. Speed is variable from 10 to 36 rpm with screen traverse movement adjustable from 0 to 1½". The separating screen operates at 350 reciprocations per minute and has removable screens in standard mesh sizes.

Circle No. **246** on Reader Service Card

Screened nickel powders

SHERRITT GORDON MINES LTD.—High purity, closely screened nickel powders are now commercially available at prices which reflect reduced sizing-premium charges.

SF (Screened Fraction) nickel powders can be supplied in eight size groups from –50+100 mesh to –500 mesh, and are available in lots of 10, 100, 500 and 2,000 pounds.

Circle No. **247** on Reader Service Card

more New Products on page 82

ONE machine–ONE operator–ONE pass

Let's face facts—costs are high and will go higher. You can, however, *REDUCE* flat finishing costs with a Hammond Flat Finisher. Grinding, deburring, and finishing of flat surfaces of plates, printed circuits, bars, stampings, extrusions, etc., can be done uniformly on a high production basis with *ONE* machine ... *ONE* operator ... *ONE* pass.

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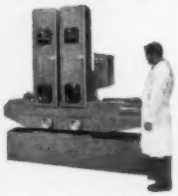

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BRIGHT, HARD, SMOOTH FINISHES

on rough, dull, unbuffed surfaces

Levelmax — the bright nickel process — reduces or eliminates surface buffing and polishing, simplifies chrome plating, makes possible bright plating of hard-to-buff areas. You get bright, smooth nickel coatings on poorly polished steel, unbuffed stampings and castings and dull copper plate. Levelmax is simple to control, has high tolerance to organic and metallic contamination, can be used under standard plating conditions. Levelling action is excellent. Levelmax bright nickel takes chrome easily. The Levelmax process is the most versatile of the nickel processes for varied product shapes, base metals and applications.

For complete working details, write on your company letterhead for Bulletin 191, Levelmax operating manual. Write Federated Metals Division, American Smelting and Refining Company, 120 Broadway, New York 5, N. Y., or call your nearest Federated sales office.

ASARCO

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Three stages in the finishing of a zinc base die casting. Casting at left was buffed. Center casting was buffed and electrocleaned in Oakite 195. Casting at right was buffed, electrocleaned in Oakite 195, and plated. Note that center casting retains full buffed lustre and color after its electrocleaning in Oakite 195.

New electrocleaner for zinc die castings assures brighter plate... and cuts rejects!

Plating of zinc base die castings now becomes a more dependable, more economical operation with the introduction of Oakite 195, a *non-etch* anodic cleaner.

More dependable because the casting surface is not etched and its color not changed or darkened. Soils and films are effectively removed, yet the castings retain their buffed lustre. To help further in preparing the way for uniformly good plating results, this new electrocleaner has excellent rinsability in hot or cold water, and low foaming tendency.

And more economical by far, because of the sharp reduction in rejects due to poor pre-cleaning.

Oakite 195 can be used with direct, reverse and periodic reverse current, in still tanks and fully automatic set-ups. Where only a single solution tank is available, it is being used to clean a variety of metals—zinc, steel, brass, copper.

For more information about this important new development in cleaning before plating, write for descriptive folder F-10466 to Oakite Products, Inc., 34G Rector Street, New York 6, N. Y.

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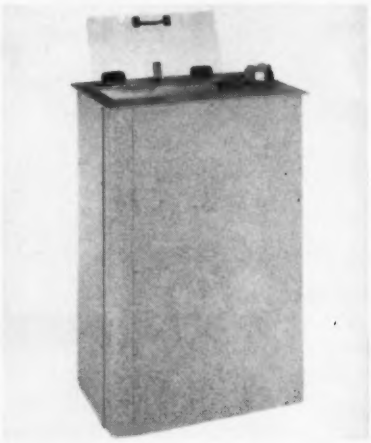
High pressure mask washer

CONFORMING MATRIX CORP.—Model W-1600 handles masks as large as 16″ x 16″ and cleans three times as fast as an agitation-type cleaner. Consumption of solvent is extremely low. The machine saves



up to 50% in time and labor over manual soaking, brushing and cleaning. It also eliminates the fire hazards of open solvent-washing tanks.

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Billet loader and scrubber

GRANCO, INC.—An automatic unit receives bundles of billets on a special table and feeds them into billet scrubbers where the surface dirt, dust and accumulations are removed by powered brushes and detergent. They are then automatically transferred to the furnace. It is reported that approximately 30% longer die life is possible with this equipment.

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Hydraulic ram and guided platen presses

HANNIFIN CO., DIV. OF PARKER-HANNIFIN CORP.—New Hannifin Series "I" utility presses have structural steel frames which meet NMTBA deflection standards. 25, 50, 75 and

100 ton capacities are offered in both ram type and guided platen models with a choice of 24″ x 24″ or 36″ x 24″ die areas. Seven power sources are available to provide a wide range of press speeds. Seven electrical control systems are also offered for this press as well as manual control and patented Sensitive Pressure control.

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Cutting-grade carbide is completely machinable

SINTERCAST DIV., CHROMALLOY CORP.—Ferro-Tic J, a new "do-it-yourself" cutting-grade carbide, is the first to combine the hot hard-

ness required in high-speed metal cutting with the easy-fabrication feature of earlier grades of Ferro-Tic.

In the annealed, as-received state, this fully sintered composite of ultrahard carbide particles dispersed in a high-speed steel matrix can be turned, drilled, milled, tapped, even filed.

Service life in cutting hardened steels compares favorably with that of conventional carbides, which can be shaped only by diamond grinding. Metal removal rates and tool life are much higher than those of high-speed tools.

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Multi-tube furnace has detachable pusher

LINDBERG ENGINEERING CO.—This four-tube diffusion furnace reaches a maximum temperature of 1300°C. in its 36″ long heating chamber, and has a rated uniformity of 18″ plus or minus 1.0° C.

Dimensions of the furnace and base only are 37″ wide, 75″ high and 52″ long. Addition of the pusher mechanism increases the length to 91″.

The pusher mechanism has an a.c. motor with transmission, ad-

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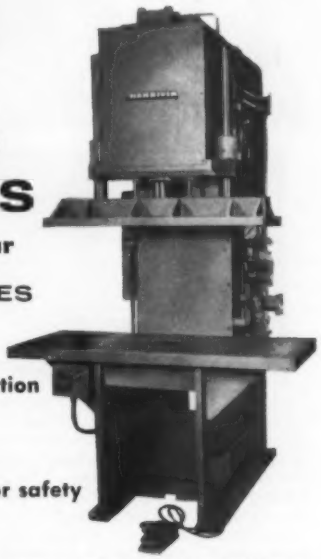

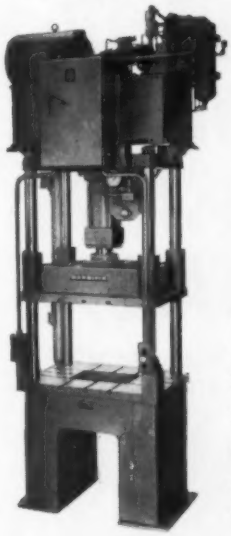

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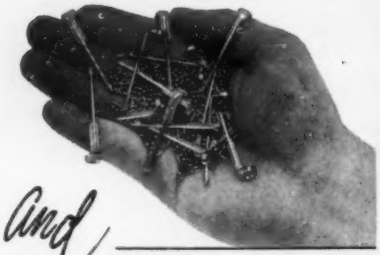
the importance of proper finish . . .



and how ABBOTT helps to get it

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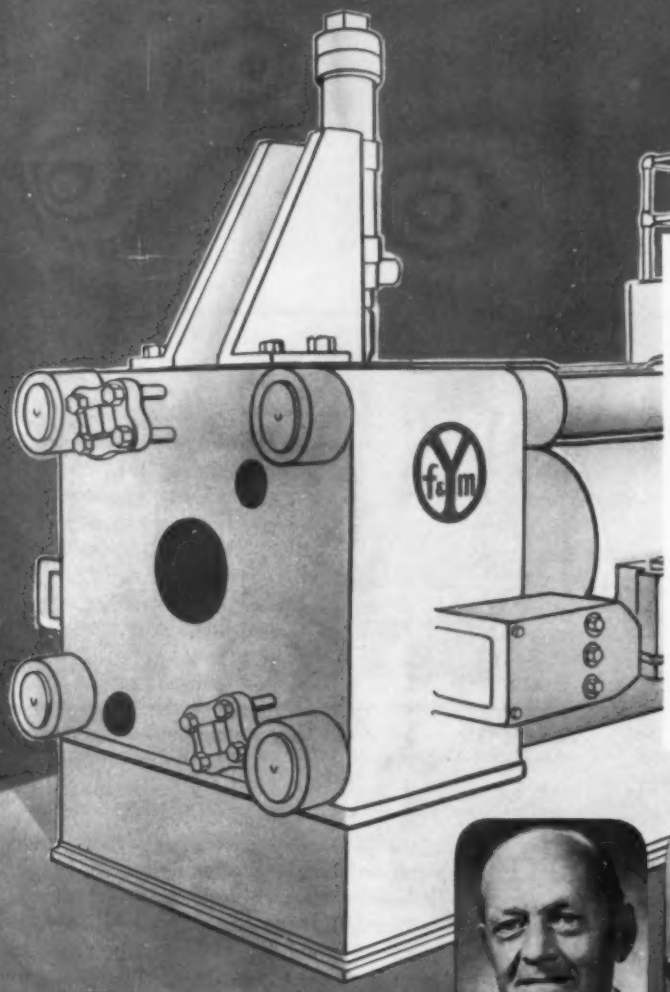
says Art G. Bauer, President, Bauer Aluminum Co., Richardson, Texas (Dallas Area)



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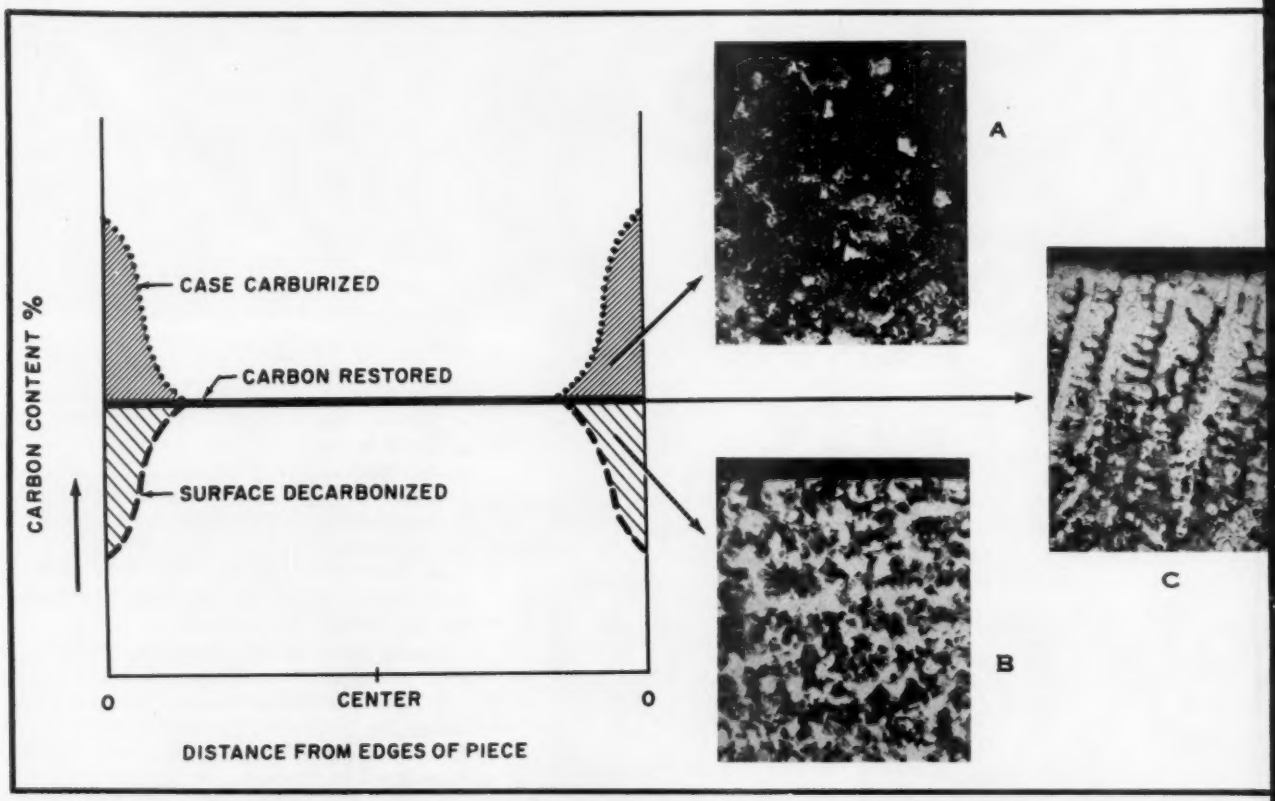
CARBON RESTORATION IN

By **E. M. BROAD,** *chief engineer, Hitchiner Mfg. Co., Inc.*



1. CARBON CONTENT vs. distance from the surface for (A) decarburized 0.040 steel as cast and annealled; (B) section of the same casting with carbon restored during annealing; and (C) section of the same casting but case carburized during annealing to about 0.050 carbon. All micrographs 50X.

THE FINAL MECHANICAL PROPERTIES and the service life of the part are dependent to a large extent on the amount of carbon in the surface layer. This makes retention of the specified carbon content imperative.

Decarburization is the loss of carbon from an iron-base alloy. It occurs on the surface of ferrous metal when the material is exposed to an atmosphere which contains oxygen, water vapor, or whose carbon potential is lower than the carbon content of the steel. The result is a soft skin of ferrite which surrounds a core of the desired carbon content metal.

In an oxidizing atmosphere (this includes both water vapor and oxygen) decarburization does not occur below 1200°F. Generally, all ferrous castings regardless of the method of casting, and all hot rolled steel will have a decarburized skin. With hot rolled stock it is possible to remove the low carbon layer by machining. This technique is rarely possible with a casting. The best solution for cast parts is, therefore, to replace the carbon which has been lost by reaction with the atmosphere. This is termed Carbon Restoration.

There has been a lot of misunderstanding about carbon restoration. Many people confuse the terms case hardening and carbon restoration. Both terms fall in the more general classification of carburization. Case hardening, or case carburizing, refers to increasing the carbon content of the surface layer to a level *above* that of the core. Carbon restoration, on the other hand, refers to increasing the carbon content of the surface layer to the same level as the core. As an example, in a piece of 8620 steel with a decarburized case, if case

carburizing is desired the carbon content of the surface layer will be increased to about 1.0%. If, however, only carbon restoration is required the carbon content of the surface layer will be brought up to 0.20%.

Figure 1 is a schematic representation, with photomicrographs, which illustrates decarburized, carbon restored, and case carburized steel. In the decarburized example the surface carbon is zero and builds up to analysis some distance in from the surface. The carbon restored sample has a uniform carbon content from edge to edge while the case carburized example has a high carbon surface which decreases to analysis some distance in from the surface.

Where parts call for carbon restoration or "skin recovery" they must not be case carburized or some of the required mechanical properties will be lost.

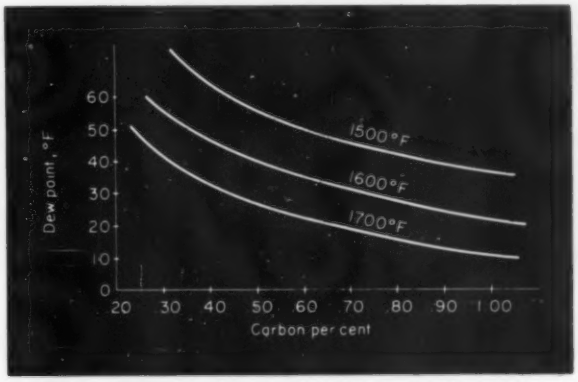
To insure proper carbon content, it is essential to hold the carbon potential of the furnace atmosphere within very close limits. This, of course, requires accurate measurement of the carbon potential of the gas.

There are a number of ways to measure carbon potential. A common one uses the relationship between the dew point of the gas and its carbon potential. Figure 2 illustrates this relationship. As the temperature decreases, the carbon potential of a gas atmosphere increases at constant dew point. Thus, if carbon restoration in a 1030 steel is done at 1700°F, the atmosphere dew point should be 40°F. However, if the furnace temperature should decrease to 1500°F, still with a 40°F dew point, the carbon potential would rise from 0.30 to 0.90 and the parts would be case carburized. The reverse is, of course, also true. A 0.90% carbon steel being carbon restored in 40°F dew point gas at 1500° would be decarburized at 1700°F. The dew point of the furnace must, therefore, be varied if the temperature is varied.

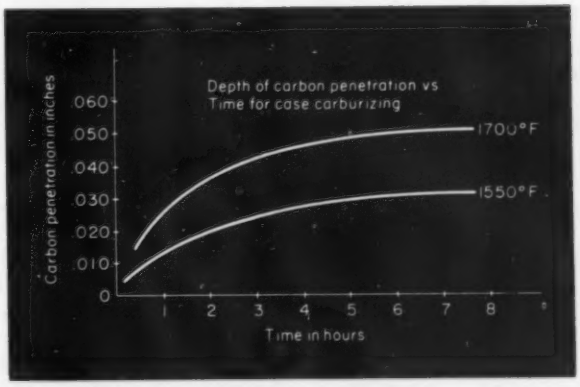
Another important consideration for both carbon restoration and for case carburizing is time at temperature. Only a short time is needed for carbon to diffuse into the metal surface boundary layer, but it takes a relatively long time for the carbon to diffuse inward into the base metal.

If it takes ten minutes for the carbon to diffuse 0.005", it would take about two hours to diffuse 0.020" and from four to six hours to diffuse 0.030". The rate of diffusion would depend on the initial carbon potential of the gas and metal as well as the temperature. Figure 3 is a typical carburizing curve which shows the effect of temperature on case depth or rate of diffusion. Carbon restoration curves are similar except that times are usually longer since the carbon potentials are usually lower.

Carbon restoration is generally an expensive and time-consuming operation. However, it is the only way to replace the exact amount of carbon which has been removed. If the properties and service require a uniform carbon content from edge to edge there is only one alternative to carbon restoration. That alternative is the machining away of the decarburized skin. But for mass produced products this is more expensive than the carbon restoration process. Therefore, in spite of the high cost of carbon restoration, there is no more economical alternative when a uniform carbon content is needed.



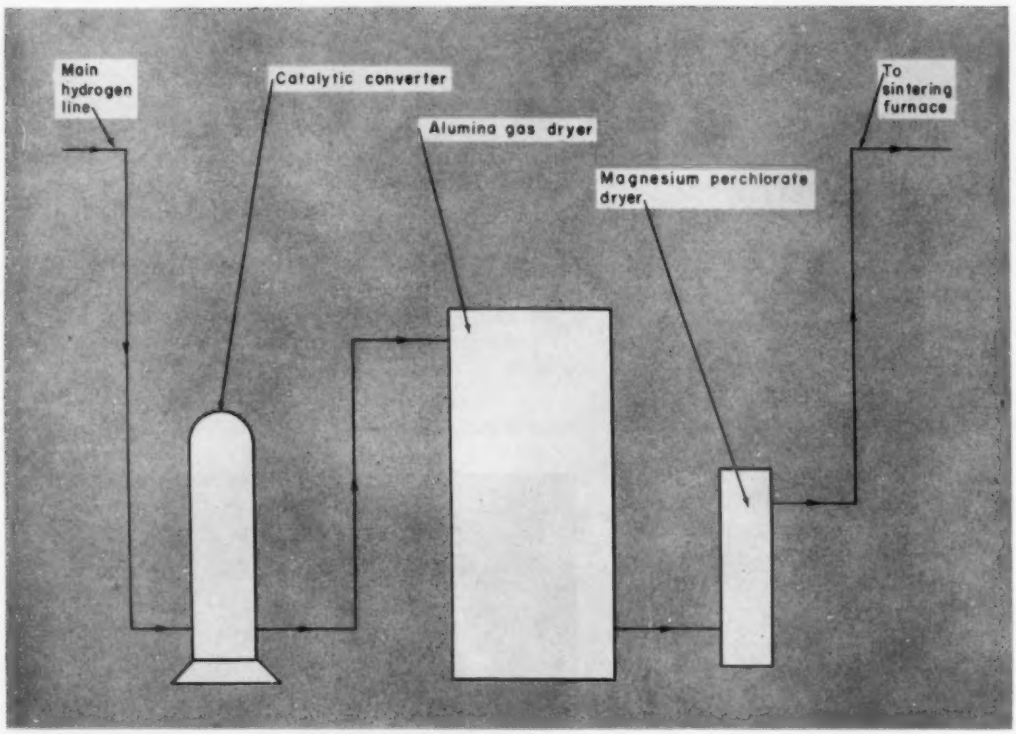
2. DEW POINT and carbon potential relationship at constant temperature for furnace atmospheres.



3. DEPTH OF PENETRATION as a function of time during case carburizing at constant temperature.

The effect of moisture during . . .

THE SINTERING OF TUNGSTEN AND



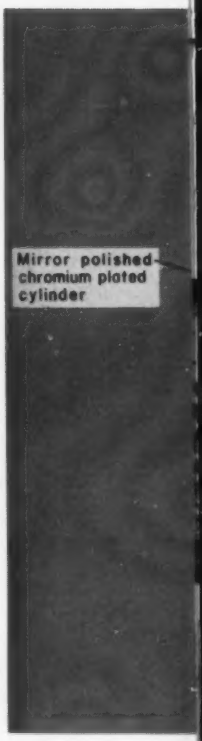


Figure 1

THE MOISTURE CONTENT of the hydrogen atmosphere controls the nucleation and grain growth during the sintering of both tungsten and molybdenum. Increasing moisture content decreases the number of nuclei and may lead to single crystal formation.

Coarse grained materials are difficult to work and may fracture during swaging and hot working. Without moisture control during sintering the hot working of metal into rods, wire, and sheet would have to be varied with each ingot. Scrap losses would be high and costs would skyrocket.

Hydrogen is always used as a protective atmosphere. It is, fortunately, easily purified and dried. Figure 1 is a schematic diagram of a hydrogen purification system. The catalyst for converting oxygen to water vapor may be copper, titanium, magnesium, or palladium. The drying media is activated alumina, anhydrous calcium chloride, sodium hydroxide, or magnesium perchlorate.

The dryness of the hydrogen is determined by measuring the dew-point. A chromium plated cylinder is cooled until moisture or ice forms on its surface. The temperature where this occurs is the dew-point. Figure 2 shows a popular type of measuring apparatus.

A typical sintering curve is shown in figure 3. This curve was made during the initial sintering stage when nucleation occurs. The rise in dewpoint from almost –50°C to –15°C is the result of oxide reduction by the hydrogen. After this first increase in moisture content there is a fairly steady fall. The final rapid fall of the dew-point is due to cooling when the power was turned off. Table I gives the data for seven typical sintering runs. The high dew-points recorded for runs B and D were due to moisture leaks in the sintering apparatus.

Gas moisture measurements will also indicate the completeness of oxide reduction. If a bar is double

MOLYBDENUM

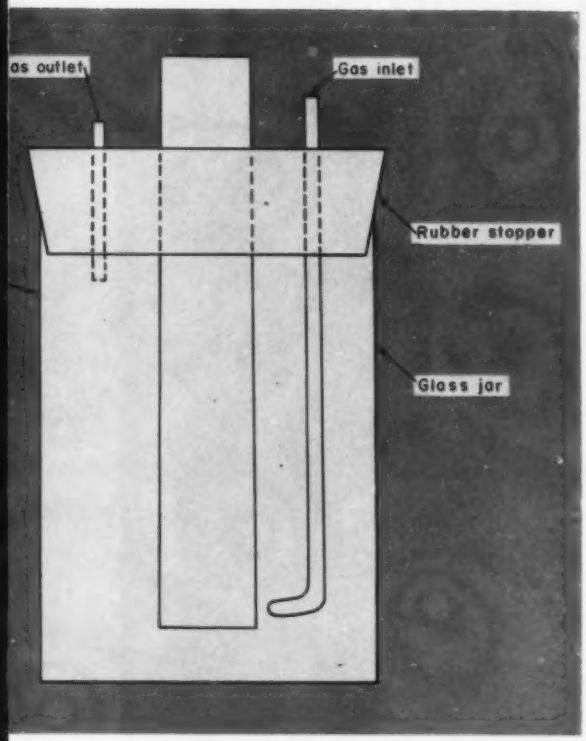


Figure 2

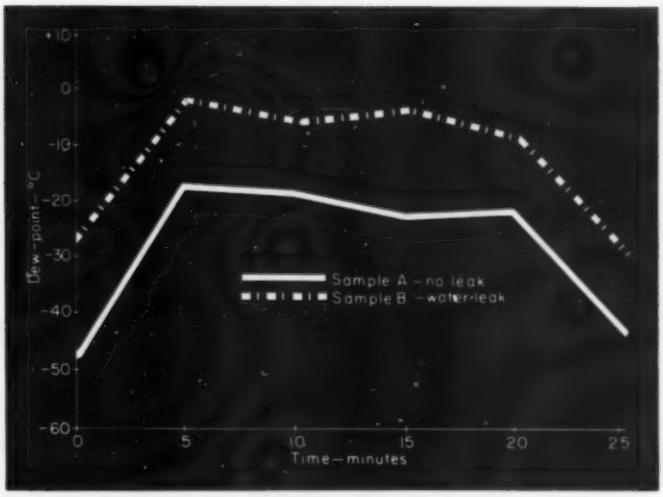


Figure 3

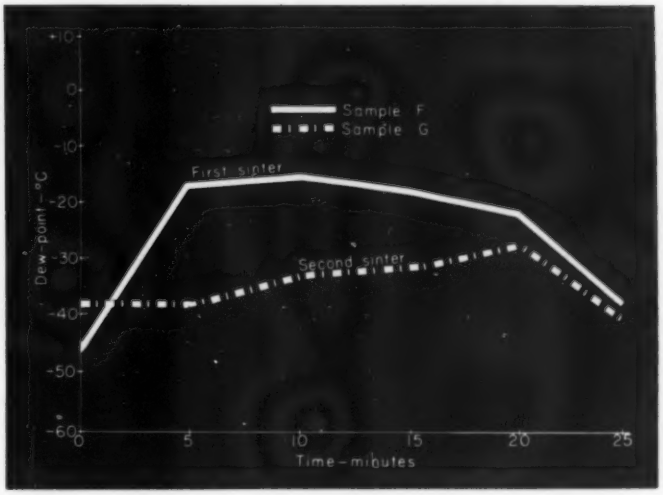


Figure 4

sintered, the second sintering will characteristically show much lower dew-points than the first one. This is shown in figure 4.

The importance of low moisture content in the protective atmosphere is easily translated into dollars. The ingots listed in Table I were processed to wire. Table II gives the percent recovery of useable wire. Samples A and E which had the lowest dew-points through the sintering run showed the highest recovery. The data for this investigation was obtained on ingots of pure tungsten. However, similar results can be expected from molybdenum & tungsten-molybdenum alloys sintered in same manner.

TABLE I—DEW POINT MEASUREMENTS DURING SINTERING

Time (min.)	Dew Point in degrees C.						
Sample	A	B	C	D	E	F	G
0 (current off)	—48	—28	—49	—54	—40	—47	—38
5 (Current on 3 min.)	—17	— 2	—17	— 2	—10	—17	—38
10	—19	— 6	—16	+ 2	—15	—15	—33
15	—24	— 4	—13	—	—16	—18	—31
20	—22	— 8	—16	—	—18	—22	—28
25 (current off)	—43	—30	—15	—	—47	—38	—40

TABLE II—PERCENT RECOVERY OF TUNGSTEN WIRE

Sample	Percent Recovery
A	73.0
B	62.5
C	48.6
E	79.4

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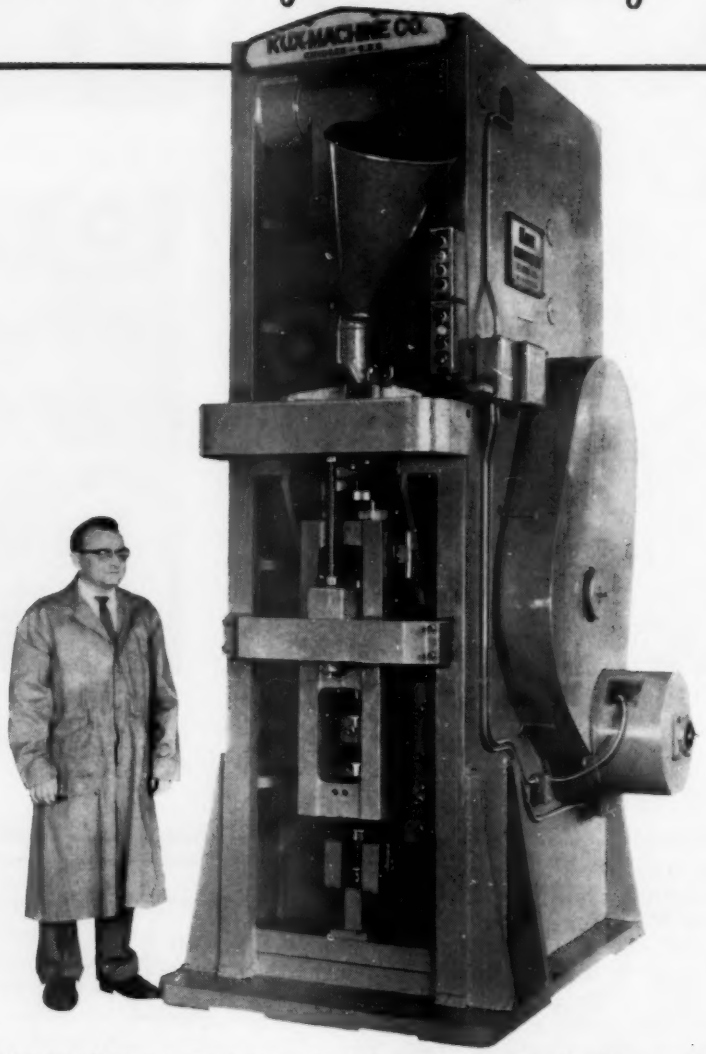

Massive, all steel, heavy duty mechanical press for powdered metals, ceramics, plastic preforms, tungsten carbides and other powdered or granular materials. An unusual feature of this machine is its capacity to eject a compact with full 125 tons pressure. Both upper and lower punches apply pressure to the part being formed with capacity of up to 6" die fill and the machine is capable of making parts up to 6" diameter or length. Dwell under compression allows compact to set while under pressure. Floating core rod mechanism with up to 4" stroke and moving die table can also be incorporated.

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Circle No. **52** on Reader Service Card

data offered in this month's ads *qualified readers may obtain any of these free reference materials by circling the numbers on the reader service cards*

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2. **Colloidal Graphite**—Acheson Colloids Co.—Brochure gives technical data on colloidal graphite dispersion problems.

4. **Additives**—Alan Wood Steel Co.—Technical bulletin gives data on the use of carbon additives.

6. **Aluminum Ingots**—Aluminium Ltd.—Technical information on Alcan 50S HO ingot for working with high press speeds with good resultant mechanical properties.

12. **Plating on Aluminum**—Enthone Div., American Smelting & Refining Co.—Detailed information on Alumon "D" dilute zincate for plating aluminum.

13. **Nickel Plating**—Levelmax Div., American Smelting & Refining Co.—Bulletin describes how to get bright plating on hard-to-buff areas.

16. **Investment Casting**—Arwood Corp.—44-page booklet includes practical tips on designing for investment casting.

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24. **Investment Casting**—Casting Engineers—8-page brochure tells how to specify for investment castings.

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30. **Standard Unit Dies**—D-M-E Corp. Technical brochure on lower costs through standardization.

32. **Sintering Furnaces**—The Electric Furnace Co.—Bulletin No. 591 describes a complete line of powder metallurgy furnaces.

37. **Metal Working Lubricants**—Fiske Brothers Refining Co.—Technical bulletins—on hot die and other specialty lubricants.

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36. **Extrusion Presses**—Feller Engineering Co.—Offers automatic rod and tube self contained extrusion presses up to 5500 tons capacity.

48. **Fire Resistant Hydraulic Fluid**—Hulburt Oil & Grease Co.—Data on properties and performance of Hul-E-Mul fire resistant fluid at savings equal to those obtained with ordinary petroleum fluid.

84. **Fire Resistant Hydraulic Fluid**—Sun Oil Co.—Offers fire resistant hydraulic fluid with performance characteristics of high-grade hydraulic oil.

41. **Die Cast Parts**—Gries Reproducer Corp.—Booklet contains helpful designer's checklist of GRC methods for creating new parts.

45. **Investment Casting**—Hitchiner Manufacturing Co.—Technical information on uses of investment casting.

54. **Die Casting Machines**—Lester-Phoenix, Inc.—Specifications give complete data on die casting equipment.

58. **Checkweighing Equipment**—Mettler Instrument Corp.—Complete data on designing for automatic weight-control system.

59. **Investment Casting**—Midwest Precision Castings Co.—Brochure describes how to design for investment casting.

63. **Impact Extrusions**—Mueller Brass Co.—Engineering Manual No. FM-3019 gives data on the Cold-Prest process for simple or relatively complex extruded shapes.

67. **Electrocleaner**—Oakite Products, Inc.—Folder describes an electrocleaner for zinc die castings.

69. **Trim Presses**—Parker-Hannifin Corp.—Bulletin describes high-speed hydraulic trimming presses.

70. **Permanent Mold Casting**—Permanent Mold Die Co.—Brochure describes the direct chill mold casting process.

71. **Lubricating Equipment**—Pierce-Waller Inc.—Information on a system for lubricating, cleaning and cooling molds.

73. **Extrusions**—Precision Extrusions, Inc.—Brochure gives detailed studies on how aluminum extrusions cut costs.

75. **Powdered Metal Parts**—Reese Metal Products Corp.—Brochure shows how to cut precision parts costs with the Remet process.

77. **Waxes**—Alex. Saunders & Co.—Bulletins, technical information on investment casting waxes.

78. **Ceramic Preformed Cores**—H. J. Sherwood, Inc.—Technical design data tells how ceramic preformed cores can be used for intricate design applications.

80. **Cold Extrusions**—Steel Industries, Inc.—Design Manual 161 gives factors in cost-saving with intricate cold extrusions.

83. **Pots**—Tiffin Foundry, Inc.—Brochure lists a line of stock pots and die casting machine accessories.

86. **Tool Steels**—Uddeholm Co. of America—Technical information on tool steels for die casting and extrusion.

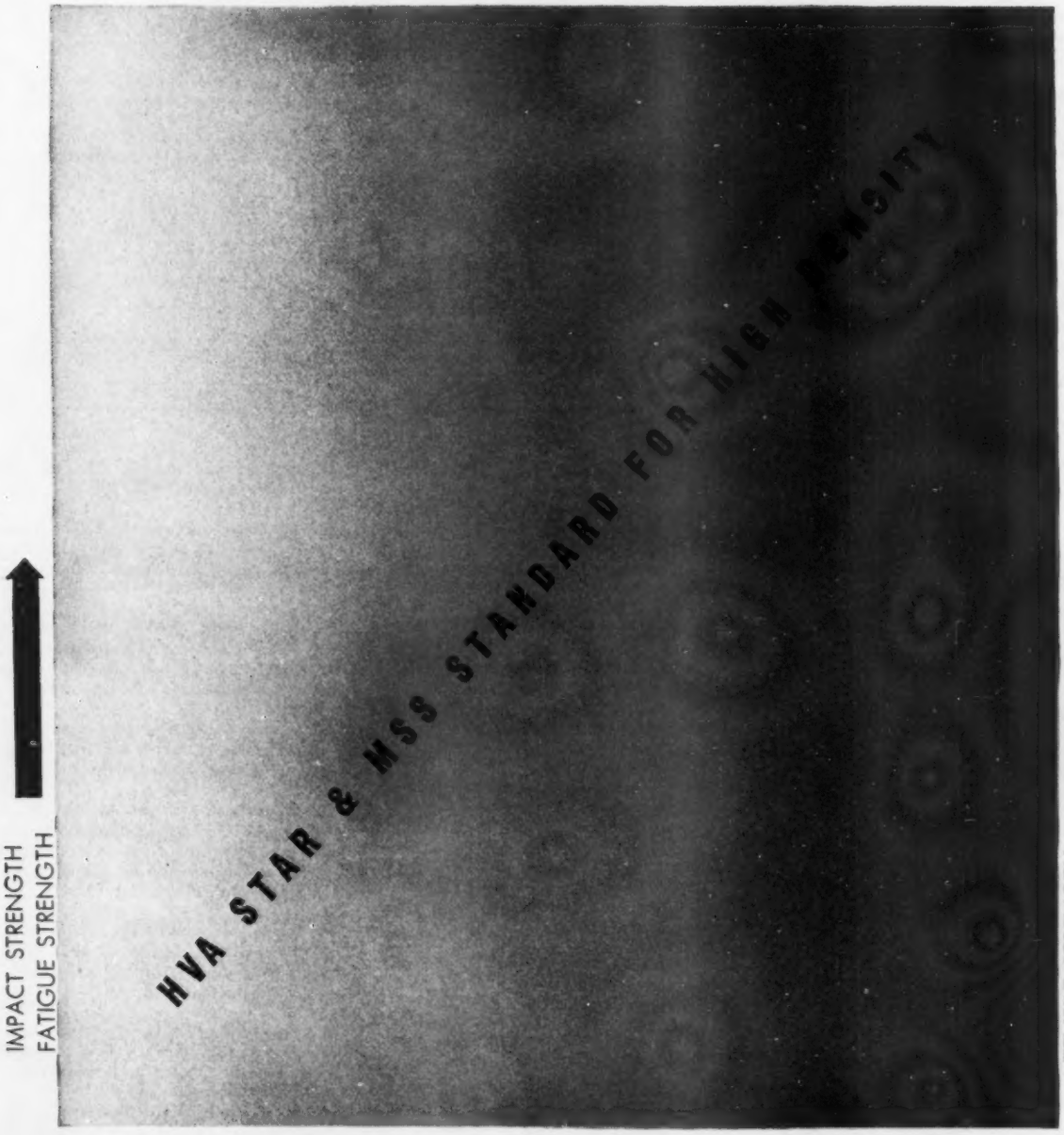
87. **Palletainers**—Union Steel Products Co.—Information on Palletainers used for handling problems.

90. **Temperature Control**—West Instrument Corp.—Bulletin describes advantages of temperature controllers.

SINTERED ALLOY STEELS

Produced From

HIGH PURITY ELEMENTAL POWDERS



A. Johnson & Co., Inc.

21 West Street, New York 6, N. Y.

Laboratory at 804 Raymond Boulevard, Newark, N. J.

Circle No. **51** on Reader Service Card

useful literature, catalogs, manuals *qualified readers may obtain*

any of these technical publications by circling the numbers on the reader service cards.

PROCESSES

145 *Permanent Mold Castings*—MELTAFORM, INC.—Brochure describes production and quality control facilities for this supplier of non-ferrous permanent mold castings.

146 *Investment Castings*—LA DONN & TECTRON—Brochure shows investment castings which were recently considered impossible, yet now are in daily production.

147 *Casting Brass & Bronze*—AMERICAN SMELTING & REF. CO.—Brochure tells how to make sound brass and bronze castings by careful control of production variables.

MATERIALS & EQUIPMENT

155 *Zoned Tube Furnace*—HARPER ELECTRIC FURNACE CORP.—Technical bulletin describes a modernized line of zoned tube furnaces featuring interchangeable components for increased versatility, includes air and atmosphere models.

156 *Degreasing Units*—UDDEHOLM CO. OF AMERICA, INC.—16-page booklet describes trichlorethylene and degreasing equipment, discusses the relative merits of vapor, spray, and immersion degreasing methods.

157 *Graphite Molds*—CARBIDE MOLD SERVICE—Bulletin describes graphite molds available for powder metallurgy applications, describes mold engineering and development services offered.

158 *Lifting Magnet*—D-M-E CORP.—Specification sheet describes a magnet for lifting steel plates weighing up to 4500 lbs.

159 *Conveyor*—MAY-FRAN MFG. CO.—Bulletin describes a continuous, automatic conveyor for more efficient in-plant handling of die castings, scrap, etc.

160 *Bearings*—JOHNSON BRONZE CO.—4-page catalog describes custom-designed and standard sleeve bearings made by powder metallurgy and centrifugal casting methods.

161 *Flaw Detector*—U.S. CASTING REPAIR CORP.—Data on a low cost system for detecting surface cracks, flaws, defects and porosity in metallic solids.

162 *Iron Powders*—MICRO METALS CORP.—Data sheet lists engineering data and price schedules for chemical grade iron powders.

163 *Tools & Dies*—BOBINCHUCK MACHINE AND TOOL CO.—Brochure lists facilities and design services for making dies, fixtures, and special machinery.

164 *Vacuum Equipment*—KINNEY VACUUM DIV.—External house organ contains news of the latest industrial applications for high vacuum pumps and vacuum equipment.

165 *Permascope*—TWIN CITY TESTING CORP.—Brochure describes a non-destructive testing device for gaging non-conductive coatings on non-ferrous base metals, the conductivity of a non-ferrous metal, the thickness of a non-ferrous coating on a non-conductor, and similar applications.

166 *Ceramic Cutting Tools*—THE CARBORUNDUM CO.—28-page booklet lists the properties, specifications, and prices for ceramic cutting tools and accessories.

167 *Zinc Alloy*—AMERICAN SMELTING & REFINING CO.—Data sheet tells why high purity zinc is vital to die cast parts, lists zinc die casting alloy compositions.

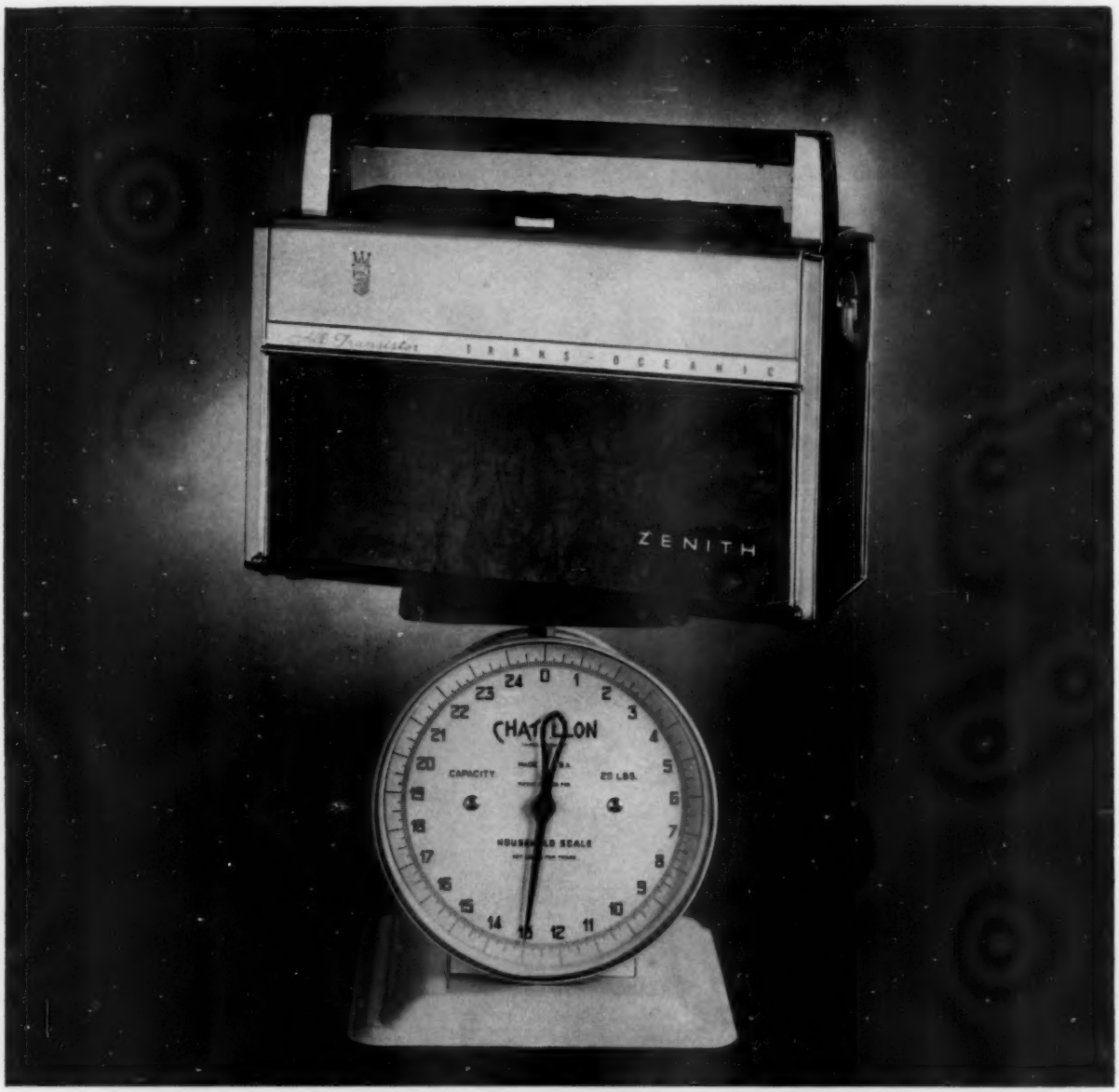
FINISHING

180 *Conversion Coating*—MAC DERMID, INC.—3-page usage and instruction sheet on a dry chromate base salt for producing corrosion resistant chemical conversion coatings on aluminum without producing dimensional changes.

181 *Coated Abrasives*—THE CARBORUNDUM CO.—50-page catalog of standard abrasive belts, rolls, sheets, and discs lists coated abrasive products used throughout industry.

182 *Soak Cleaner*—MAC DERMIC INC.—3-page usage and instruction sheet on a general purpose soak cleaner that removes oil, grease, and buffing compound from all metals.

more Useful Literature on page 95



ASSIGNMENT: A weighty one. Take the Zenith Royal 1000 Transoceanic portable radio and pare off half of its 26 pounds—without reducing performance. How do you do it? With an aluminum case? No. With plastics? No. You do it with a housing made from eleven thin-wall, high strength zinc die castings. You do it with the only material and method that can provide the "as cast" tolerances necessary for the flush-fit the design demands. You rely on a material that can be cast thinner, and yet stronger, than any die casting competitor; a material whose castability permits shapes and intricate sections prohibitively expensive by other fabricating techniques. You know that assembly will be easy, because you can use self-tapping screws, and speed nuts on the cast bosses. You know that finishing will be a pleasure, with a smooth surface that readily accepts bright, satin and brush-finish chrome plate, as well as paint to fill the cast lettering. We could go on and on, detailing the advantages each one of the eleven zinc die castings demonstrates, pointing out the skillful designing that combines a multitude of functional and decorative duties. However, all you need do is look at the scales above and remember—zinc die casting gives you more for less. How else would you make it?

Zinc die castings by Paragon Die Casting Company, Chicago, Illinois.

NJZ
THE NEW JERSEY ZINC CO.
160 FRONT STREET • NEW YORK 38, N. Y.

Circle No. **65** on Reader Service Card

useful literature, catalogs, manuals

183 ***Centrifugal Enameler***—LEON J. BARRETT CO.—Brochure tells how highly flammable coatings are applied safely by an air powered centrifugal enameler.

184 ***Vacuum Metallizing***—F. J. STOKES CORP.—16-page brochure tells all about the vacuum metallizing process for depositing a thin layer of metal on various surfaces.

185 ***Vibratory Finishing***—PANGBORN CORP.—12-page bulletin lists details and specifications on a complete line of vibratory finishing equipment.

186 ***Tapping Screws***—PARKER-KALON DIV.—22-page technical booklet lists hole size recommendations and application information for tapping screws.

187 ***Sand Blaster***—UNIVERSAL INDUSTRIAL SUPPLY CO.—Data sheet describes a sand blasting unit for removing rust, paint, and chemicals, and for cleaning hard-to-get-at places.

188 ***Buffing & Polishing***—THE LEA MFG. CO.—20-page technical manual covers manual and semi-automatic polishing, deburring, satin finishing, buffing, and high coloring of metals.

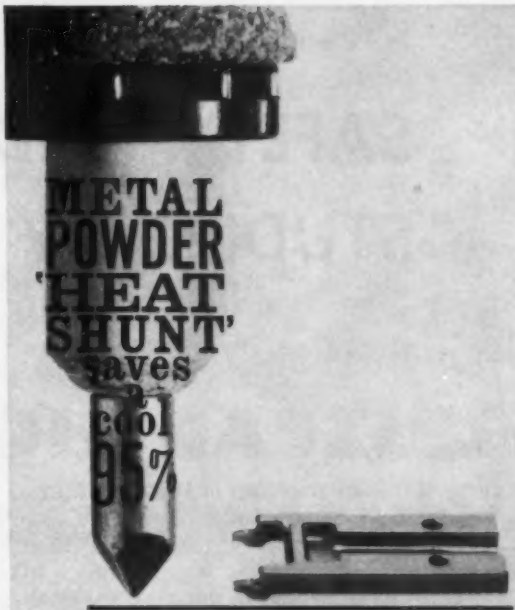
. . . and how they can cut your costs!

● Eliminate secondary machining operations, raise production rates, improve product quality. This eight-page brochure shows how to specify precision Minicast parts and conventional investment castings for your problem components.

Includes two reference pages for designers—general design features, tolerances and complete tabulation of castable metals and alloys. Money-saving hints for purchasing men, too. *Send for your copy today!*

CASTING ENGINEERS
Two Plants: Chicago • New York City

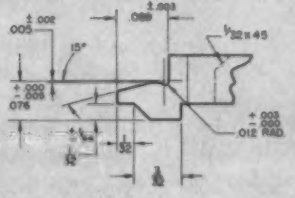
2321 North Bosworth Avenue • Chicago 14, Illinois
Circle No. **24** on Reader Service Card



The heat shunt shown above is pressed from pre-alloyed bronze powder and hard-chrome plated. It is used to position electronic components on printed circuit boards and eliminate heat damage when soldering.

Design teamwork between Kwikset Powdered Metal Products and Autonetics Division of North American Aviation has resulted in a part which is produced at a 95% cost saving over previous machining methods.

The heat shunt is easily produced in four precise end modifications to locate components at various angles. When soldering,



the high heat conductivity of the bronze protects the components and circuit from melting by drawing off heat produced at the solder joint. The heat shunt itself is solderproof thanks to its hard-chrome plate.

This time-saving printed circuit tool demonstrates that, working together, the metal powder fabricator and his customer can lick the hottest problem. To find out how to put nonferrous powder metallurgy to work for you, write today to the New Jersey Zinc Company, producers of nonferrous metal powders setting tomorrow's standards today.

NJZ
THE NEW JERSEY ZINC CO.
160 FRONT STREET · NEW YORK 38, N.Y.

Circle No. **66** on Reader Service Card

SAFETY AND MARKETING STUDIED BY ADCI

HEXTER-PMM AWARD

In memory of the late publisher of PRECISION METAL MOLDING Magazine, Lester P. Aurbach, president, The Industrial Publishing Corp., announced the establishment of, and the first winner of the "Hexter-Precision Metal Molding Award." The award, $350, is made to an engineering college student based on scholastic standing, interest in the die casting process, and financial need.

NATHASON

All engineering students in colleges which are cooperating with the ADCI in die casting education are eligible.

The award winner this year is Marshall R. Nathason, now starting his senior year at California State Polytechnic College.

Nathason is an Industrial Engineering student who, in the opinion of the faculty, has shown exceptional ability in machine shop and manufacturing methods courses and an outstanding interest in the die casting process and its future potential.

BAUER WINS DOEHLER AWARD

The highest award of the American Die Casting Institute went, this year, to Alfred F. Bauer, manager, Doehler-Jarvis Div., National Lead Co.

BAUER

While the award was made in recognition of Bauer's work on the first successful water cooled, die cast aluminum engine block, it also recognizes the many outstanding contributions Bauer has made to the advancement of the die casting art in both this country and abroad.

In making the award, Frank J. Koegler, vice president and a director of the National Lead Co. said that "The reliable performance of the die cast aluminum engine block in the 1961 American Motors automobiles must be regarded as the most important single accomplishment to date in an industry noted for unusual firsts."

The adoption of the die cast block for a mass-produced automobile is the culmination of work started by Doehler-Jarvis in 1951. Through every stage of the development it has been Bauer's firm belief that an all-aluminum die cast engine would some day be adopted by all automobile manufacturers.

ADCI ELECTS OFFICERS, VOICES OPTIMISM

At the annual meeting of the ADCI, safety and marketing came in for a full day of study and discussion. At the meeting, held in Chicago on September 27-28 Walter E. Brown, executive vice-president of the Kiowa Corp., Marshalltown, Iowa, was elected president for the coming year. Before his election as president of ADCI, Brown served two terms as an Institute vice-president.

BROWN

While the first half of this year was not up to expectations, third quarter business and prospects for the fourth quarter indicate a marked upturn. The ADCI estimates that production of aluminum die casting in 1961 will top the 365,500,000 pound production set in 1960. Zinc die castings will probably fall short of last years 312,500 tons by about 10%, but increased production of both brass and magnesium die castings may bring the 1961 production figures equal to or only slightly lower than total die casting production in 1960.

For 1962, the die casters forecast a good year. Un-

continued on page 98

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BEST
FOR
UPSETTING
PIERCING
EXTRUDING
FORGING

PRODUCES MORE AND BETTER PIECES BETWEEN DIE CHANGES.

A graphited product for use in working hot metals of all kinds. Good in temperatures up to 2200° F and above. Keeps work cool and extends the life of dies and punches. Highly adhesive, may be applied by brush or swab or diluted with oil for spraying.

Bulletins describing Fiske's 514A Hot Die Lubricant and other specialty lubricants and coolants sent on request.

FISKE'S

FISKE'S METAL WORKING LUBRICANTS

FISKE BROTHERS REFINING CO.
129D Lockwood Street, Newark 5, N. J.
Plants: Newark 5, N. J. Toledo 5, Ohio

---

quality
INVESTMENT CASTINGS
delivered on time!

- Assure the success of your investment casting designs. Send them to Midwest Precision, which has an enviable background of many years of experience in the field.

Among the great number of investment castings successfully mass-produced by Midwest, are many parts on which other foundries failed. Our engineers and technicians make available to YOU, without obligation, their full store of accumulated precision casting knowledge.

To be sure of your investment cast parts, submit them to Midwest for a completely unbiased evaluation.

FREE Send for your copy of "How To Design Investment Castings"

MIDWEST PRECISION CASTINGS CO.
10703-11 QUINCY • CLEVELAND 6, OHIO
GArfield 1-7918 A-3119

Circle No. 59 on Reader Service Card

For your zinc or aluminum

Instrument Parts

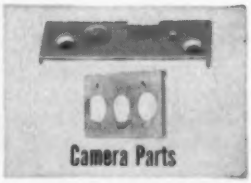
Small Engine Cylinders

DIE CASTINGS CHOOSE ADVANCE

because . . .

Motor Housings

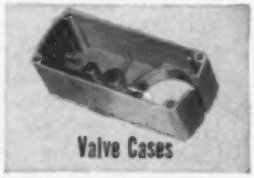
above and beyond the measurable factors of metallurgical control and mechanical equipment (which others may also possess to a degree) there are at ADVANCE creative engineering, in-plant tool making, production skill and management attitudes toward customer requirements not always encountered in run-of-the-mill markets.


Camera Parts

ADVANCE supplies zinc and aluminum components to fine product makers from Texas to Massachusetts as well as to its good neighbors in the Mid-west. Geographical distance is no barrier to quality production.

Control Valve Components

So . . . check with ADVANCE for your zinc or aluminum die casting requirements.


Valve Cases

These symbols are your assurance of highest quality control of zinc and aluminum alloys under ADCI standards

ADVANCE TOOL AND DIE CASTING CO.
38 years of service to industry
3872 N. Holton St.
Milwaukee 12, Wis.

Circle No. 3 on Reader Service Card

Automatic Checkweighing
FROM Milligrams TO Kilograms

If you are interested in high speed, high precision automatic weighing of low weight range objects, you should consider Mettler checkweighing equipment.

Mettler automatic equipment is presently used to control production of aspirin, golf balls, ping pong balls, batteries, billets, bullets, butter, buttons, canned goods, cigarettes, dental supplies, foodstuffs, gold nuggets, hammer handles, magneto magnets and missile parts. In short, everything from dehydrated soup to zinc nuts.

Mettler checkweighing balances and their associated control unit outputs are used for physical sorting, control of machinery, or statistical control of production. Relay as well as analog output permit use with a wide selection of standard auxiliary control elements.

These balances, complete with any one of twelve control unit types, are available from stock in capacities of 1, 3, 10, 30, 100, 300, and 1000 grams. Weighing speeds of 40 to 90 per minute can be easily achieved, either with a Mettler standard transport system or a system of your own design.

How does automatic weight control fit into your production picture? Write for complete data on Mettler KWA checkweighing equipment and on feeding and sorting systems.

METTLER INSTRUMENT CORPORATION

P. O. BOX 100, PRINCETON, NEW JERSEY

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SAFETY AND MARKETING STUDIED BY ADCI

less world conditions change present business outlooks, aluminum die casting production should continue to rise, zinc die casting production should at least equal the 350,000 ton level which is normal for a good automotive year. Brass and magnesium die casting should continue to rise next year.

NEWTON

KAUFMAN

SHIRTUM

YAUSSI

Elected to office at the annual ADCI meeting: W. G. Newton, Jr., president, The Newton-New Haven Co., ADCI vice-president; G. E. Kaufman, elected chairman of the ADCI Central Regional Group; R. C. Shirtum, elected chairman of the ADCI Midwestern Regional Group; Frank D. Yaussi, elected chairman of the ADCI Pacific Coast Regional Group.

In addition to the offices listed, all four men become members of the Board of Directors of the ADIC.

DIE CASTING RESEARCH FOUNDATION REPORTS ACTIVITIES

One arm of the ADCI is its Die Casting Research Foundation. This activity was set up to study the many basic facets of the die casting industry, to develop new and/or improved techniques, new and better materials and alloys.

Principal reports covered the search for new materials to give longer life to dies and machine parts; an evaluation of new lubrication techniques to speed production; the study of metal flow in die casting dies; and the development of a compatible vacuum die casting system.

Vacuum and venting systems

Patents were recently granted the research foundation on its vacuum die casting system. The original

plans were to make this system available, under license, to the 120 member plants only. At the meeting, however, the directors reported that plans are under study to make this system available to any die caster who can qualify under the licensing arrangement.

According to the DCRF report, this new vacuum and venting system permits the continuous evacuation of the die cavity until it is completely filled with metal. This is accomplished without the use of a valve in the vacuum passage. Direct, continuous pressure measurement in the cavity throughout the casting cycle is possible. When desired, relatively low pressures can be obtained. Consistent, reproducible evacuation to 27.5″ Hg is practical.

In addition to vacuum die casting, the new system permits massive venting of the die without the use of reduced pressures in the die cavity.

The use of vacuum die casting is expected to extend the application of die castings into many new fields as well as to improve production of present die castings in those cases where high surface finish, pressure tightness, or a high degree of section strength and uniformity is required. The reduced porosity which results from vacuum die casting will eliminate much of the blistering and scaling on the surface when the castings are baked at a high temperature or shot blasted.

NEW DIE CASTING PRODUCT STANDARD

The ADCI Marketing Committee announced that a new Product Standard (ADCI-C9-61) is now available. This standard will provide a precedure and data sheet for the buyer of die castings when requesting estimates. The hope is that much of the guess work in quotations will be eliminated if both buyer and vendor have a complete understanding of exactly what a quotation is to cover. (Note: For a complete description of this new standard as well as a sample data sheet, watch for "Buying Practices" to be included in the November 1961 issue of PRECISION METAL MOLDING.)

AUSTIN T. LILLEGREN AWARD

Two Austin T. Lillegren Awards were made at the ADCI meeting this year. These awards are in memory of one of the leading figures in the American die casting industry, and for many years the vice-president of the Madison-Kipp Corp.

One award went to Norman Dress, Precision Castings Co., for his service on the ADCI National Safety committee. Mr. Dress has been largely responsible for the effective safety programs conducted by the ADCI for many years. He has served on the safety committee since 1948 and has been its chairman since 1954.

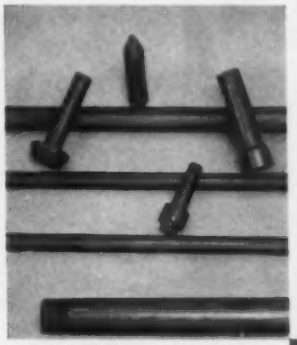
The second Lillegren award went to R. C. Cornell, vice-president, Litemetal Dicast, Inc., for his outstanding service on the technical committee of the Die Casting Research Foundation. Mr. Cornell has devoted much of his time and talent to guiding key research activities as chairman of various technical committee task groups.

Q WHAT ONE MATERIAL

can be used up to 3000°F—is nearly impervious to abrasion and corrosion—can be formed to ± .005 in./in.—and even withstands molten aluminum?

A Carborundum's nitride bonded silicon carbide — REFRAX® refractory

This extra hard, very strong material looks like cast iron—wears like no other known refractory or cement—yet costs little more than standard silicon carbides. And it's worth?—you judge from the examples below.



EXAMPLE: Cast iron pyrometer tubes immersed in molten aluminum average 70 hours' life. When replaced with REFRAX tubes, life is *ten times* longer. Iron pouring spouts in molten aluminum cut out in an hour. Contamination of the melt is "distinct." Life of REFRAX spouts is often several hundred hours... and there's no longer contamination.

EXAMPLE: REFRAX brick, rectangular or with tongue and groove, used in hot walls are easy to clean and maintain, resist NaCl, KCl and cryolite fluxes added to metal, speed up heat conductivity and extend wall life. Life of REFRAX hot walls consistently proves to be several times that of fireclay walls.

EXAMPLE: Automatic precision pouring of molten aluminum is governed by REFRAX float that serves as the "nerve end" of electronic system. Refractory float is of simple design, requires practically no maintenance and provides a life 4 to 5 times that of floats made of other materials.

The successful development of REFRAX refractory—a ceramic that can be *used like a metal* under conditions that metal parts can't take—is now a service-tested fact. Of equal importance, this product can be made *in a variety of compositions* to fit your particular service conditions... and scaled in cost to your price limits. For details, contact Dept. R-101, The Carborundum Co., Perth Amboy, N. J.

CARBORUNDUM®

Circle No. 23 on Reader Service Card

DESIGNING A NEW PRODUCT?

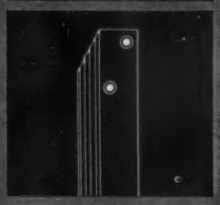
ask Superior about its money-saving aluminum extrusions

CABINET DOOR HANDLE

Extrusion includes rubber bumper adapter; mitered ands; drilled, countersunk, drilled and thread-tapped holes.

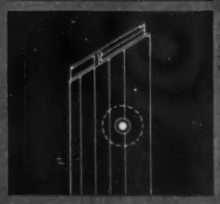
DOOR SLIDE RAIL

45° mitered, drilled, countersunk, polished, chemically brightened and anodized.



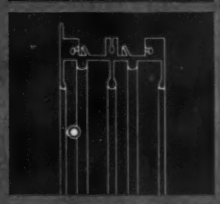
BOTTOM DOOR RAIL

(This section holds a nylon roller wheel.) Mitered, drilled, countersunk and precision thread tapped.



BOTTOM TRACK RAIL

Mitered, milled contours, drilled, countersunk, polished and anodized.



KICK RAIL

Notched, punched, polished, chemically brightened and anodized.

Let Superior show you how you can save money in many ways on your aluminum extrusions. The Mohawk cabinet above is an example of how this leading manufacturer gets extrusions perfectly fabricated from Superior Industries. The extrusions fit perfectly into Mohawk's production line without any further operation. Under one roof, Superior controls the fabricating and refinishing of all these parts, ready for assembly.

In addition to extruding intricate shapes, Superior miters, bends, rivets, drills, countersinks and notches the metal. Chemical and hand polishing, spray painting, anodizing and etching get professional attention. This entire performance saves you labor and factory time. And, thousands of companies have already taken advantage of Superior's complete services.

Send us samples, blueprints, or ask us to call. Superior engineers are now ready to help you to save in many ways.

ALUMINUM EXTRUDERS • ANODIZERS • ARTRIM MOULDINGS

SUPERIOR INDUSTRIES INC.

3788 Oakwood Ave.
Youngstown, Ohio

Circle No. **82** on Reader Service Card

2nd annual

EXTRUSION DIRECTORY

PART 1

ABOUT THIS DIRECTORY

THE LISTINGS in this directory are limited to those companies who filled in, signed, and returned to us a detailed questionnaire. Since not all companies co-operated, this listing is known to be incomplete. However, every listing given has been verified and comprises about 75% of the known custom extruders in the country.

Only the corporate sales office for each company has been listed since this is strictly a buyers guide rather than a geographical listing of extrusion plants.

In many cases the letters M and/or F appear. This indicates that the facility will do some machining and/or surface finishing on extruded shapes before shipment. For details of the operations which can be done either consult the individual extruders or inquire of PRECISION METAL MOLDING. Note also that advertisers in this issue are listed in bold faced type. More information about these companies can be secured by refering to the individual advertisements.

On page 63 of this issue are tables of the properties of extrudable metals and alloys. Reference to these tables will enable designers and purchasing men to select the best metal or alloy for a particular application and the companies who can make the extrusion in the selected material.

EXTRUDERS

STRAIGHT EXTRUSIONS

ALUMINUM

Adams Engineering Co.
P. O. Box 875
Ojus, Fla. (M, F)

Adams & Westlake Co., The
1025 N. Michigan St.
Elkhart, Ind. (M, F)

Aerolite Extrusion Co.
4605 Lake Park Rd.
Youngstown 12, Ohio (F)

Alsco, Inc.
225 S. Forge St.
Akron 8, Ohio (M, F)

Aluminum Co. of America
1501 Alcoa Bldg.
Pittsburgh 19, Pa. (M, F)

Aluminum Extruded Shapes, Inc.
10549 Reading Rd.
Cincinnati 41, Ohio (M, F)

F—Company does finishing
M—Company does machining

Aluminum Extrusion Co.
3042 Treadwell St.
Los Angeles, Calif. (F)

Aluminum Shapes, Inc.
815 W. Shepherd St.
Charlotte, Mich. (M, F)

Aluminum Shapes, Inc.
9000 River Rd.
Delair, N.J.

Alumitron Corp.
704 W. Water St.
Taunton, Mass. (M, F)

American Art Metals Co.
433 Highland Ave., N.E.
Atlanta 12, Ga. (M, F)

American-International Aluminum Corp.
495 Brokaw Rd.
San Jose, Calif. (M)

American-International Aluminum Corp.
4851 N. W. 36th Ave.
Miami, Fla. (M, F)

V. E. Anderson Mfg. Co.
P. O. Box 121
Rome, Ga. (M, F)

Aywon Wire & Metal Corp.
745-64th St.
Brooklyn 20, N.Y. (M, F)

B & T Metals Co., The
2240 S. Garfield Ave.
Los Angeles 22, Calif. (M, F)

B & T Metals Co., The
425 W. Town St.
Columbus 16, Ohio (M, F)

Badger Aluminum Extrusions Corp.
950 Georgia Ave.
Brooklyn 7, N.Y. (M, F)

Barberton Metal Products Co.
24 Huston St.
Barberton, Ohio

Bauer Aluminum Co.
100 W. Spring Valley Rd.
Richardson, Texas (F)

Bayless Products, Inc.
P. O. Box 188
Damascus, Ohio

Bell Co., The
Weather-Tite Div.
P. O. Box 310
Bedford, Ohio (M, F)

Benson Aluminum Co., Inc.
R. R. 1
Connersville, Ind.

Bohn Aluminum & Brass Corp.
1400 Lafayette Bldg.
Detroit 26, Mich. (M, F)

William L. Bonnell Company, Inc., The
78 Fair St.
Newnan, Ga. (M, F)

Brazeway, Inc.
2711 E. Maumee St.
Adrian, Mich. (M, F)

continued on next page

4 more cost-cutting examples of

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Bridgeport Brass Co.
Hunter-Douglas Div.
3016 Kansas Ave.
Riverside, Calif. (M, F)

Bristol Aluminum Co.
P. O. Box 11
Bristol, Pa. (M)

Calex Corp.
2415 Wilson Ave.
Campbell, Ohio (M)

Capitol Products Corp.
P. O. Box 69
Mechanicsburg, Pa. (M)

Channel Master Corp.
Ellenville, N.Y. (M, F)

Corson Industries
9000 River Rd.
Delair, N.J. (F)

Croft Metal Products, Inc.
McComb, Miss. (M, F)

Dibbs Aluminum Products, Inc.
520 So. MacDill Ave.
Tampa 9, Fla. (M)

Dow Metal Products Co., The
Div. of The Dow Chemical Co.
Midland, Mich. (M, F)

Extruded Alloys, Inc.
800-900 X Street
Bedford, Ind. (M, F)

Extruded Aluminum Co.
P. O. Box 470
Summerville, S. C. (M, F)

Fentron Industries, Inc.
2801 N. W. Market St.
Seattle 7, Wash. (M, F)

C. M. Flynn Mfg. Co.
26051 Michigan Ave.
Inkster, Mich (M, F)

Flynn Extrusion Corp.
900 So. Marshall St.
Marshall, Mich. (M, F)

Michael Flynn Mfg. Co.
700 E. Godfrey Ave.
Philadelphia 24, Pa. (M, F)

General Extrusions, Inc.
4040 Lake Park Rd.
Youngstown, Ohio (M, F)

Greater Louisville Industries, Inc
835 Spring St.
Jeffersonville, Ind. (M, F)

Harvey Aluminum
19200 S. Western Ave.
Torrance, Calif. (M, F)

Hillman Mfg.
Acorn Aluminum Div.
2020 Chico Ave.
South El Monte, Calif. (M)

Himmel Brothers Co., The
1409 Dixwell Ave.
Hamden, Conn. (M, F)

Jarl Extrusions, Inc.
Linden Ave.
East Rochester, N. Y. (M, F)

Jasco Aluminum Products
Div. of Irving Air Chute Co., Inc.
31 Nassau Terminal Rd.
New Hyde Park, L. I., N. Y. (M, F)

Jerex Corp.
336 Bayview Ave.
Amityville, N. Y.

Kaiser Aluminum & Chemical Corp.
300 Lakeside Dr.
Oakland 12, Calif. (M, F)

Kawneer Co.
Aluminum Mill Products Div.
Powis Rd.
St. Charles, Ill. (F)

Kinkead Industries, Inc.
5860 N. Pulaski Rd.
Chicago, Ill. (M, F)

Kroh-Wagner
2341 N. Pulaski Rd.
Chicago 39, Ill. (M, F)

Light Metals Corp.
2750 Prairie St.
Grand Rapids 9, Mich. (M, F)

Loxcreen Co., Inc., The
4983 S. Peachtree Rd.
Chamblee, Ga. (M, F)

Macklanburg-Duncan Co.
P. O. Box 1197
Oklahoma City, Okla. (M, F)

Mainline Extrusions, Inc.
2601-2605 So. Main St.
South Bend 14, Ind. (M, F)

Mala Extrusions, Inc.
610-37th Ave.
Rock Island, Ill. (F)

Matthews Corp.
12848 Weber Way
Hawthorne, Calif. (M)

May, Inc.
5803 Alief Rd.
Houston 5, Texas (M, F)

Metal Trims, Inc.
P. O. Box 632
Jackson, Miss. (M, F)

Miami Extruders, Inc.
3775 NW 77th St.
Miami, Fla.

Mideast Aluminum Corp.
U. S. Highway 130
Dayton, N. J. (F)

Midwest Aluminum Corp.
7696 West Michigan
Kalamazoo, Mich. (F)

Miller Industries, Inc.
Reed City, Mich. (M, F)

Mueller Brass Co.
1925 Lapeer Ave.
Port Huron, Mich. (M, F)

National Extrusion & Mfg. Co.
Orchard at Elm St.
Bellefontaine, Ohio (M, F)

New Jersey Aluminum Extrusions Co.
Box 73
North Brunswick, N. J. (M, F)

New York Metal Molding, Inc.
Cambridge & Leithgow Sts.
Philadelphia, Pa. (M, F)

New York Metal Moulding Co., Inc.
19-22—45th St.
Astoria 5, N. Y. (M, F)

North American Extrusions Corp.
5569 N. Riverview Dr.
Kalamazoo, Mich. (M, F)

Northeast Aluminum, Inc.
65 Manchester St.
Lawrence, Mass. (M, F)

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M—Company does machining

continued on next page

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Metals Div.
400 Park Ave.
New York 22, N. Y. (M)

Pacific Extrusions, Inc.
P. O. Box 1018
Watsonville, Calif. (M, F)

Pax Metal Corp.
14533 Keswick St.
Van Nuys, Calif. (M, F)

F. A. Pilgrim Extrusions, Inc.
4449 Lake Park Rd.
Youngstown 12, Ohio (M, F)

Pittsburgh Aluminum Alloys
Box 207
Murrysville, Pa. (M, F)

Precision Extrusions, Inc.
720 E. Green Ave.
Bensenville, Ill. (M)

Purpose Extruded Aluminum, Inc.
111 Mechanic St.
Hudson, Mich. (M, F)

Quaker State Metals Co.
Extrusion Div.
Standiford Field
Louisville 13, Ky. (M, F)

Quality Aluminum Products Co.
16180 Meyers Rd.
Detroit 35, Mich.

Revere Copper & Brass, Inc.
230 Park Ave.
New York 17, N.Y. (M)

Reynolds Metals Co.
6601 W. Broad St.
Richmond, Va. (M, F)

Rogers Industries, Inc.
14575 Meyers Rd.
Detroit 27, Mich. (M)

Ronson Metals Corp.
55 Manufacturers Place
Newark 5, N.J. (M, F)

Royal Aluminum, Inc.
Box 3023, Terminal Annex
Los Angeles 54, Calif. (M, F)

Royce Aluminum Corp.
704 W. Water St.
Taunton, Mass. (M, F)

Saramar Aluminum
4021 Mahoning Ave.
Youngstown, Ohio (M, F)

Alan Scott Aluminum Corp.
777 Main St.
Westbury, L.I., N.Y. (M, F)

F. E. Schumacher Co.
200 Mill St.
Hartville, Ohio (M)

Seasonmaster, Inc.
777 Main St.
Westbury, L.I., N.Y. (M, F)

Southern Extrusions, Inc.
P. O. Box 750
Magnolia, Ark. (M, F)

Southern Extrusions, Inc.
6910 Preston Highway
Louisville, Ky. (M, F)

Superior Industries, Inc.
3786 Oakwood Ave.
Youngstown, Ohio (M, F)

Titus Metals Corp.
P. O. Box 810
Waterloo, Iowa (M)

Trim Alloys, Inc.
360 North St.
Randolph, Mass. (M, F)

Union Aluminum Co., Inc.
111-119 Raleigh Ave.
Sheffield, Ala. (M, F)

U. S. Extrusions Corp.
120 Old Broadway
Garden City Park, N.Y. (M, F)

Valley Metal Products Co.
800 E. Bridge St.
Plainwell, Mich. (M, F)

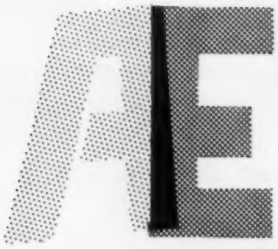
Warner Mfg. Co.
265 Watsessing Ave.
Bloomfield, N.J. (M, F)

Warrenville Window & Door Co.
Mount & Manning St.
Warrenville, Ill. (M)

Wells Aluminum Corp.
278 Henry St.
North Liberty, Ind. (M)

R. D. Werner Co., Inc.
Box 580
Greenville, Pa. (M, F)

White Metal Rolling & Stamping Co., The
80 Moultrie St.
Brooklyn 22, N.Y. (M, F)



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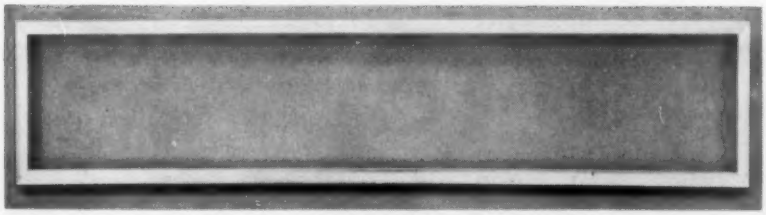

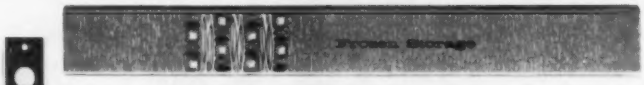

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Metalonics Corp.
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Boston, Mass. (M, F)

Nuclear Metals, Inc.
P. O. Box 222
Concord, Mass. (M)

BRASS

Anaconda American Brass Co.
414 Meadow St.
Waterbury 20, Conn. (M)

Bohn Aluminum & Brass Corp.
1400 Lafayette Bldg.
Detroit 26, Mich. (M, F)

Bristol Brass Corp., The
580 Broad St.
Bristol, Conn. (M)

Chase Brass & Copper Co.
236 Grand St.
Waterbury, Conn. (M)

Chicago Extruded Metals Co.
1821 S. 54th Ave.
Cicero 50, Ill.

H. M. Harper Co., The
8200 Lehigh Ave.
Morton Grove, Ill. (M, F)

Janney Cylinder Co.
7401 State Rd.
Philadelphia 36, Pa. (M)

Lewin-Mathes Co.
Div. of Cerro Corp.
1111 Chouteau Ave.
St. Louis 2, Mo. (M, F)

Mueller Brass Co.
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Port Huron, Mich. (M, F)

Revere Copper & Brass, Inc.
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New York 17, N.Y. (M)

Scovill Mfg. Co.
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Waterbury, Conn. (M, F)

Titan Metal Mfg. Co.
Div. of Cerro Corp.
Bellefonte, Pa. (M)

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Mueller Brass Co.
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Scovill Mfg. Co.
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Chicago Extruded Metals Co.
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Lewin-Mathes Co.
Div. of Cerro Corp.
1111 Chouteau Ave.
St. Louis 2, Mo. (M, F)

Metalonics Corp.
40 W. Third St.
Boston, Mass. (M, F)

Mueller Brass Co.
1925 Lapeer Ave.
Port Huron, Mich. (M, F)

Revere Copper & Brass, Inc.
230 Park Ave.
New York 17, N.Y. (M)

Scovill Mfg. Co.
99 Mill St.
Waterbury, Conn. (M, F)

LEAD

Industrial Metals Alloy Co.
P. O. Box 445 Salem Station
Winston-Salem, N.C.

Vulcan Lead Products Co.
1545 W. Pierce
Milwaukee 4, Wisc. (M)

White Metal Rolling & Stamping Co.
80 Moultrie St.
Brooklyn 22, N.Y. (M, F)

MAGNESIUM

Aluminum Extrusion Co.
3042 Treadwell St.
Los Angeles, Calif. (F)

Dow Metal Products Co., The
Div. of The Dow Chemical Co.
Midland, Mich. (M, F)

Purpose Extruded Aluminum, Inc.
111 Mechanic St.
Hudson, Mich. (M, F)

White Metal Rolling & Stamping Co., The
80 Moultrie St.
Brooklyn 22, N.Y. (M, F)

SILVER

Metalonics Corp.
40 W. Third St.
Boston, Mass. (M, F)

STEEL

(low alloy and carbon)

Allegheny Ludlum Steel Corp.
Oliver Bldg.
Pittsburgh 22, Pa. (M)

Babcock & Wilcox Co., The
Tubular Products Div.
Beaver Falls, Pa.

Cornell Forge Co.
6666 West 66th St.
Chicago 38, Ill.

H. M. Harper Co., The
8200 Lehigh Ave.
Morton Grove, Ill. (M, F)

Matthews Corp.
12848 Weber Way
Hawthorne, Calif. (M)

New York Metal Molding, Inc.
Cambridge & Leithgow Sts.
Philadelphia, Pa. (M, F)

F—Company does finishing
M—Company does machining

STEEL

(high alloy and stainless)

Allegheny Ludlum Steel Corp.
Oliver Bldg.
Pittsburgh 22, Pa. (M)

Babcock & Wilcox Co., The
Tubular Products Div.
Beaver Falls, Pa.

Cornell Forge Co.
6666 West 66th St.
Chicago 38, Ill.

H. M. Harper Co., The
8200 Lehigh Ave.
Morton Grove, Ill. (M, F)

Harvey Aluminum
19200 S. Western Ave.
Torrance, Calif. (M, F)

Matthews Corp.
12848 Weber Way
Hawthorne, Calif. (M)

New York Metal Molding, Inc.
Cambridge & Leithgow Sts.
Philadelphia, Pa. (M, F)

TIN

Industrial Metals Alloy Co.
P. O. Box 445 Salem Station
Winston-Salem, N.C.

White Metal Rolling & Stamping Co., The
80 Moultrie St.
Brooklyn 22, N.Y. (M, F)

TITANIUM

Babcock & Wilcox Co., The
Tubular Products Div.
Beaver Falls, Pa.

H. M. Harper Co., The
8200 Lehigh Ave.
Morton Grove, Ill. (M, F)

Harvey Aluminum
19200 S. Western Ave.
Torrance, Calif. (M, F)

Janney Cylinder Co.
7401 State Rd.
Philadelphia 36, Pa. (M)

Metalonics Corp.
40 W. Third St.
Boston, Mass. (M, F)

Titanium Metals Corp. of America
233 Broadway
New York 7, N.Y. (M)

URANIUM

Nuclear Metals, Inc.
P. O. Box 222
Concord, Mass. (M)

Scovill Mfg. Co.
99 Mill St.
Waterbury, Conn. (M, F)

ZINC

Janney Cylinder Co.
7401 State Rd.
Philadelphia 36, Pa. (M)

ZIRCONIUM

Allegheny Ludlum Steel Corp.
Oliver Bldg.
Pittsburgh 22, Pa. (M)

continued on page 108

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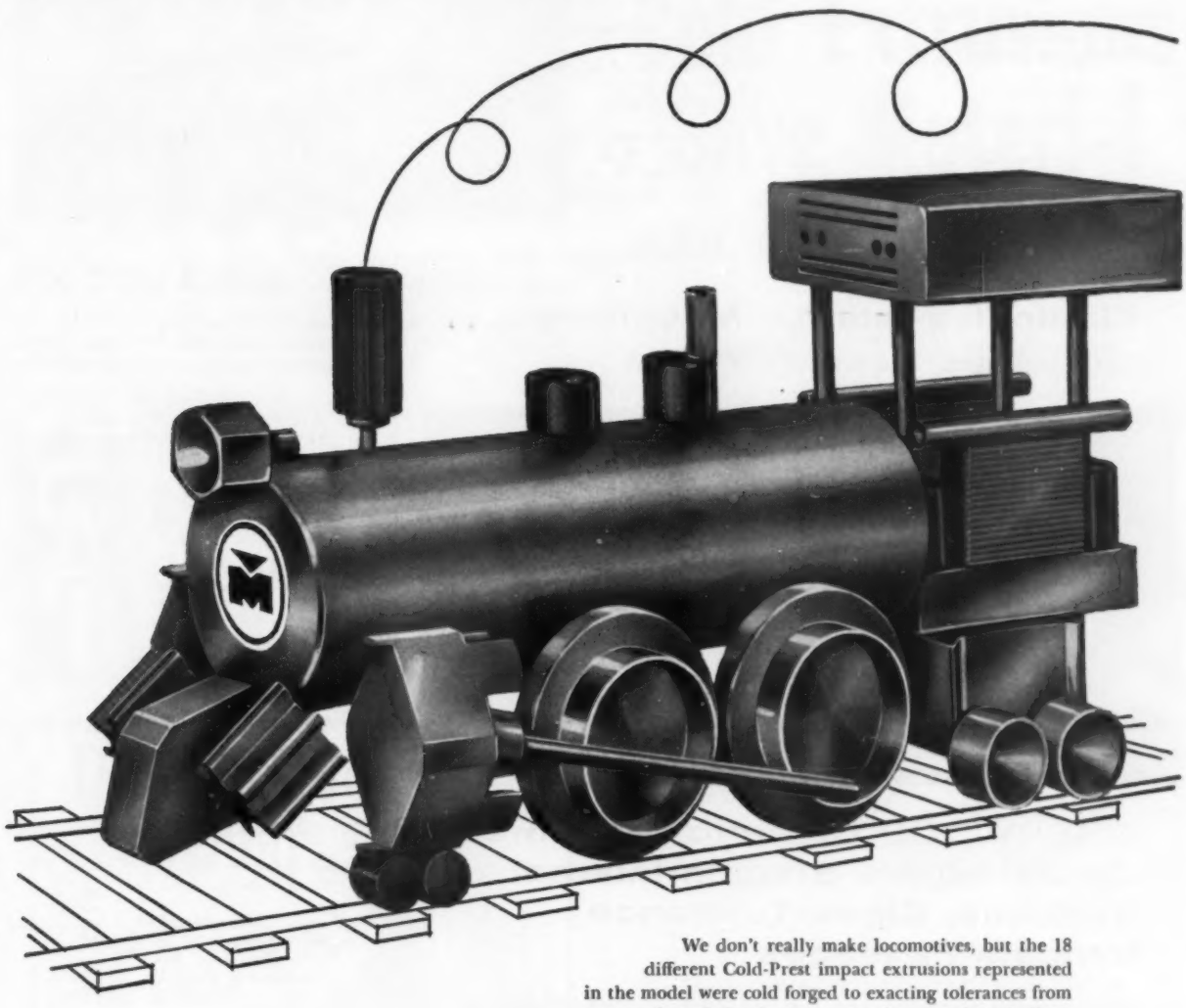

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Beaver Falls, Pa.

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Torrance, Calif. (M, F)

Janney Cylinder Co.
7401 State Rd.
Philadelphia 36, Pa. (M)

Metalonics Corp.
40 W. Third St.
Boston, Mass. (M, F)

Nuclear Metals, Inc.
P. O. Box 222
Concord, Mass. (M)

Scovill Mfg. Co.
99 Mill St.
Waterbury, Conn. (M, F)

IMPACT EXTRUSIONS

ALUMINUM

Aluminum Co. of America
1501 Alcoa Bldg.
Pittsburgh 19, Pa. (M, F)

American Extrusion Corp.
Div. A. H. Wirz, Inc.
17-19 Meadow St.
Brooklyn 6, N.Y. (M)

Braun Engineering Co.
19001 Glendale
Detroit 23, Mich. (M)

Bridgeport Brass Co.
Hunter-Douglas Div.
3016 Kansas Ave.
Riverside, Calif. (M, F)

Cliff Mfg. Co.
30240 Lakeland Blvd.
Wickliffe, Ohio (M, F)

Harvey Aluminum
19200 S. Western Ave.
Torrance, Calif. (M, F)

Impact Extrusion Products, Inc.
39 Power House Rd.
Roslyn Heights, N.Y. (M)

Impact Extrusion Co.
Turbotville, Pa. (M, F)

Impact Extrusions, Inc.
2102 Calumet Rd.
Valparaiso, Ind.

Jasco Aluminum Products
Div. of Irving Air Chute Co., Inc.
31 Nassau Terminal Rd.
New Hyde Park, L.I., N.Y. (M, F)

Kaiser Aluminum & Chemical Corp.
300 Lakeside Dr.
Oakland 12, Calif. (M, F)

Matthews Corp.
12848 Weber Way
Hawthorne, Calif. (M)

Mueller Brass Co.
1925 Lapeer Ave.
Port Huron, Mich. (M, F)

National Impacted Metal Corp.
P. O. Box 726
New Albany, Miss. (M)

Scovill Mfg. Co.
99 Mill St.
Waterbury, Conn. (M, F)

Steel Industries, Inc.
Crawfordsville, Ind. (M)

Thompson Ramo-Wooldridge, Inc.
Main Plant Div.
2196 Clarkwood Ave.
Cleveland 3, Ohio (M, F)

Torrance Brass Foundry, Inc.
1825 W. 213th St.
Torrance, Calif. (M)

Valley Metal Products Co.
800 E. Bridge St.
Plainwell, Mich. (M, F)

BERYLLIUM

Steel Industries, Inc.
Crawfordsville, Ind. (M)

Torrance Brass Foundry, Inc.
1825 W. 213th St.
Torrance, Calif. (M)

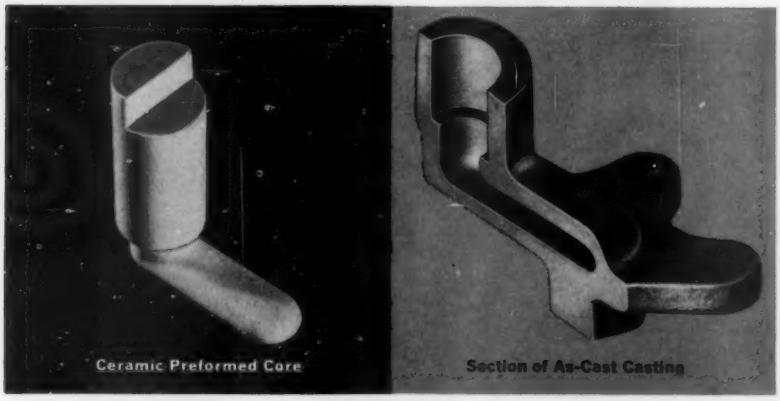
BRASS

Braun Engineering Co.
19001 Glendale
Detroit 23, Mich. (M)

F—Company does finishing
M—Company does machining

continued on page 110

Eliminates Internal Machining . . . Increases Casting Yields



SHERWOOD Ceramic Preformed Cores Assure Smooth Internal Surfaces; Close-Tolerance Intricate Passages

This stabilized Sherwood core, inspected for accuracy and surface uniformity, solved a problem inherent in blind-hole design and production. The length and configuration of the small passage made conventional processing impossible. The manufacturer produced this casting without internal blisters, voids or other defects. Although the production run was small, the yield was 100%—proof of the reliability of Sherwood preformed ceramic cores for intricate design application.

- Hold internal tolerances within ±.005" or closer depending on size or configuration
- Produce as-cast internal surfaces of 100 RMS or better
- Permit pouring temperatures in excess of 3000°F
- Resist thermal shock without warping or fracture
- Eliminate metal/core reaction with any alloy
- Assure complete design freedom in size or configuration

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Sherwood Refractories
Division of H. J. Sherwood, Inc.
16601 Euclid Avenue • Cleveland 12, Ohio

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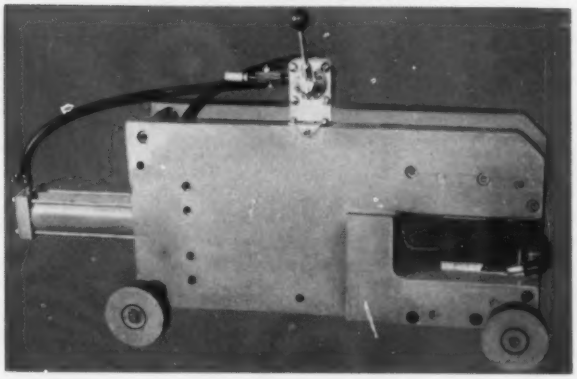
Circle No. 26 on Reader Service Card



For Your Extrusion Stretching...

CLARK not only supplies the stretcher head pictured above, but also the complete stretching unit in various tonnage sizes to suit your particular needs.

let CLARK solve your extrusion problems

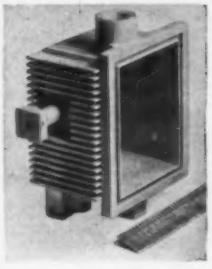
CLARK
UTOMATION
INC
324 W. MAIN STREET
BELDING, MICH.
PHONE: 1555

- Walking beam cooling tables
- Walking beam storage tables
- Run out tables
- Live belt conveyors
- Lift overs
- Pull overs
- Carbon canisters and sections

Precise Investment Casting

for

High Production!
Fine Finish!
Low Reject Rate!



LIEBROS CASTING CO., INC.

Saunders Investment Casting Materials help you make Precise Investment Castings. Intricate parts with cores, under-cut sections, etc., can be cast in one piece at one time! Production can be increased, tolerances held closely with fine surface finish.

Sherwood Wax Injection Presses work at lower temperatures to give precise pattern production — Saunders "Blue Wax" has high tensile strength, hard surface and low ash content to give castings a better surface finish and reliable adherence to tolerance. High Quality Refractory Materials offered for shell or monolithic molds. Complete plant set-up for precision investment casting available including Ovens, Fluidized Beds, Turntable Mixers and melting equipment.

Write for Information today,
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Alexander Saunders & CO., INC.
95 Bedford Street, New York 14, N. Y.

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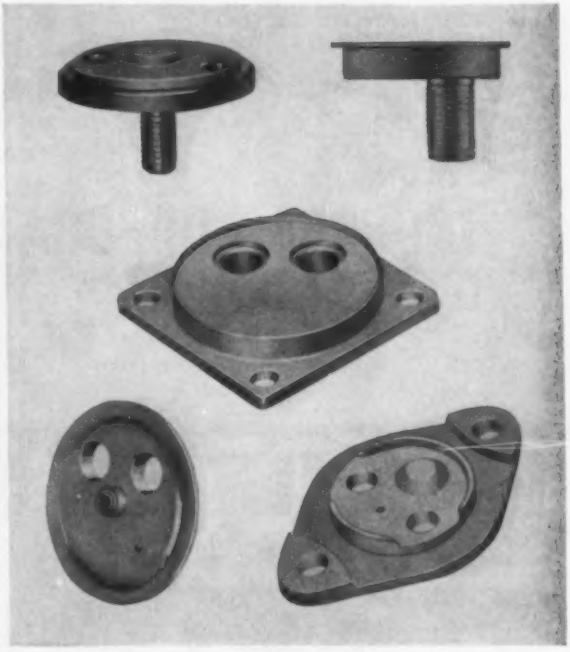
intricate

Cold Extrusions Save Material

and cut your costs!



Machining wastes material—shaves it right away. The more complex the contour, the more stock that must be cut away in order to produce the part, such as these copper transistor and diode bases.

Intricate cold extrusion saves material by forcing just enough of it into a precise shape. Often less than a quarter of the amount of machine stock is needed for cold extrusions, and this material savings is passed on to you in reduced costs. Other advantages include:

- **Design Freedom**
- **Cold-worked Properties**
- **Accuracy**
- **High Production Rates**

Whatever your application, these factors can help cut your costs. Contact Steel Industries, now, for engineering consultation. Ask for Design Manual 161.

STEEL INDUSTRIES, INC.
CRAWFORDSVILLE, INDIANA

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Circle No. 49 on Reader Service Card

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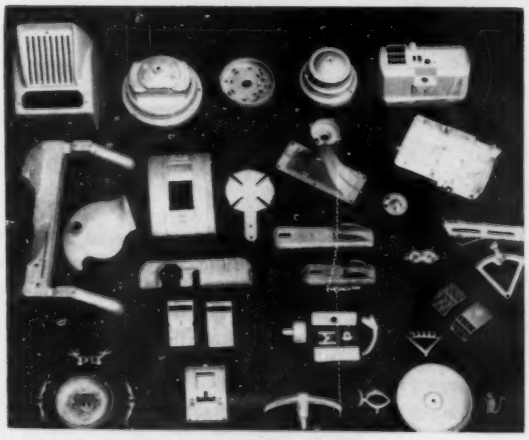

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Impact Extrusions, Inc.
2102 Calumet Rd.
Valparaiso, Ind.

Impact Extrusion Co.
Turbotville, Pa. (M, F)

Matthews Corp.
12848 Weber Way
Hawthorne, Calif. (M)

Mueller Brass Co.
1925 Lapeer Ave.
Port Huron, Mich. (M, F)

Steel Industries, Inc.
Crawfordsville, Ind. (M)

Torrance Brass Foundry, Inc.
1825 W. 213th St.
Torrance, Calif. (M)

BRONZE

(including nickel silver,

Impact Extrusion Co.
Turbotville, Pa. (M, F)

Matthews Corp.
12848 Weber Way
Hawthorne, Calif. (M)

Steel Industries, Inc.
Crawfordsville, Ind. (M)

Torrance Brass Foundry, Inc.
1825 W. 213th St.
Torrance, Calif. (M)

COPPER

Braun Engineering Co.
19001 Glendale
Detroit 23, Mich. (M)

Impact Extrusion Co.
Turbotville, Pa. (M, F)

Impact Extrusions, Inc.
2102 Calumet Rd.
Valparaiso, Ind.

Matthews Corp.
12848 Weber Way
Hawthorne, Calif. (M)

Mueller Brass Co.
1925 Lapeer Ave.
Port Huron, Mich. (M, F)

Steel Industries, Inc.
Crawfordsville, Ind. (M)

Torrance Brass Foundry, Inc.
1825 W. 213th St.
Torrance, Calif. (M)

LEAD

Matthews Corp.
12848 Weber Way
Hawthorne, Calif. (M)

MAGNESIUM

Mueller Brass Co.
1925 Lapeer Ave.
Port Huron, Mich. (M, F)

National Impacted Metal Corp.
P. O. Box 726
New Albany, Miss. (M)

Torrance Brass Foundry, Inc.
1825 W. 213th St.
Torrance, Calif. (M)

F—Company does finishing
M—Company does machining

continued on page 112

Circle No. 57 on Reader Service Card

EXTRUSION DIE STEELS PRESS PARTS

Requirements for high quality containers, liners, stems and die blanks for the extruding of all metals and alloys can be met more efficiently and economically by Marathon. A wide range of steel grades is available, each one offering excellent service life and machinability.

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For Zinc Die Casting — Cold Hobbed Dies — **UHB PREMO** — SAE P-4

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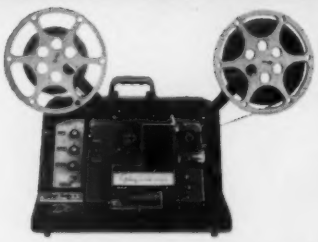
6th IN A SERIES of POWDERED METAL PARTS applications by REESE



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AND
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POWDERED METAL PARTS

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SILVER

Mueller Brass Co.
1925 Lapeer Ave.
Port Huron, Mich. (M, F)

Steel Industries, Inc.
Crawfordsville, Ind. (M)

STEEL

(low alloy and carbon)

Braun Engineering Co.
19001 Glendale
Detroit 23, Mich. (M)

Cliff Mfg. Co.
30240 Lakeland Blvd.
Wickliffe, Ohio (M, F)

Heintz Div.
Kelsey-Hayes Co.
Front St. & Olney Ave.
Philadelphia 20, Pa. (M, F)

Matthews Corp.
12848 Weber Way
Hawthorne, Calif. (M)

Mueller Brass Co.
1925 Lapeer Ave.
Port Huron, Mich. (M, F)

Steel Industries, Inc.
Crawfordsville, Ind. (M)

STEEL

(high alloy and stainless)

Impact Extrusion Co.
Turbotville, Pa. (M, F)

Matthews Corp.
12848 Weber Way
Hawthorne, Calif. (M)

Steel Industries, Inc.
Crawfordsville, Ind. (M)

TIN

Steel Industries, Inc.
Crawfordsville, Ind. (M)

TITANIUM

Torrance Brass Foundry
1825 W. 213th St.
Torrance, Calif. (M)

URANIUM

Torrance Brass Foundry, Inc.
1825 W. 213th St.
Torrance, Calif. (M)

ZINC

Impact Extrusion Products, Inc.
39 Power House Rd.
Roslyn Heights, N.Y. (M)

National Impacted Metal Corp.
P. O. Box 726
New Albany, Miss. (M)

ZIRCONIUM

Torrance Brass Foundry, Inc.
1825 W. 213th St.
Torrance, Calif. (M)

Suppliers' listings begin on page 113

2nd annual

EXTRUSION DIRECTORY

PART 2

EQUIPMENT & SUPPLIES

EXTRUSION FORMING EQUIPMENT

Baldwin-Lima-Hamilton Corp.
Industrial Equipment Div.
Philadelphia 42, Pa.
(regular extrusion presses, run-out tables, stretchers, straighteners)

Belco Industries, Inc.
9138 Belding Rd.
Belding, Mich.
(run-out tables, cooling tables)

Birdsboro Corp.
Birdsboro, Pa.
(regular extrusion presses, run-out tables, stretchers)

Clark Automation, Inc.
324 W. Main St.
Belding, Mich.
(run-out tables, stretchers)

Elmes & King Mfg. Co.
1150 Tennessee
Cincinnati 29, Ohio
(regular extrusion presses)

Feller Engineering Co.
1101 Empire Bldg.
Pittsburgh 22, Pa.
(regular extrusion presses, run-out tables, stretchers, straighteners)

Granco, Inc.
317 32nd St., S.W.
Grand Rapids 8, Mich.
(run-out tables)

Lake Erie Machinery Corp.
500 Woodward Ave.
Buffalo 17, N.Y.
(regular extrusion presses, impact extrusion presses, stretchers, straighteners)

Loma Machine Mfg. Co., Inc.
114 E. 32nd St.
New York 16, N.Y.
(run-out tables, stretchers, straighteners)

Lombard Corp.
639 Wick Ave.
Youngstown 1, Ohio
(regular extrusion presses, run-out tables, stretchers, straighteners)

Permanent Machine & Tool Co.
835 Wall St.
Florence, Ala.
(run-out tables, stretchers, straighteners)

Permanent Mold Die Co., Inc.
2275 E. Nine Mile Rd.
Hazel Park, Mich.
(extrusion pullers, walking beam tables)

Sutton Engineering Co.
1306 First National Bank Bldg.
Pittsburgh 22, Pa.
(regular extrusion presses, run-out tables, stretchers, straighteners)

Verson Allsteel Press Co.
1355 E. 93rd St.
Chicago 19, Ill.
(regular extrusion presses, impact extrusion presses)

Watson-Stillman Press Div.
Farrel-Birmingham Co., Inc.
565 Blossom Rd.
Rochester 10, N.Y.
(regular extrusion presses, run-out tables, stretchers, straighteners)

Youngstown Foundry & Machine Co., The
W. Federal & Reserve Sts.
Youngstown, Ohio
(regular extrusion presses, run-out tables, stretchers, straighteners)

FURNACE EQUIPMENT

Ajax Magnethermic Corp.
3990 Simon Rd.
Youngstown, Ohio
(billet heaters, melting furnaces, heat treating furnaces)

Despatch Oven Co.
619 S.E. 8th St.
Minneapolis 14, Minn.
(heat treating furnaces)

Belco Industries, Inc.
9138 Belding Rd.
Belding, Mich.
(billet heaters, heat treating furnaces)

Extrusion Ingot Co.
720 E. Green Ave.
Bensenville, Ill.
(billet heaters, billet casters, melting furnaces, heat treating furnaces)

Granco, Inc.
317 32nd St., S.W.
Grand Rapids 8, Mich.
(billet heaters, heat treating furnaces)

Grieve-Hendry Co., Inc.
1350 N. Elston Ave.
Chicago 22, Ill.
(extrusion die heaters, melting furnaces)

Hevi-Duty Electric Co.
304 Hart St.
Watertown, Wisc.
(billet heaters, melting furnaces, heat treating furnaces)

International Foundry Supply Co.
Box 1053
Reading, Pa.
(billet casters, melting furnaces)

Lanly Co., The
2800 Euclid Ave.
Cleveland 15, Ohio
(billet heaters, billet casters, heat treating furnaces)

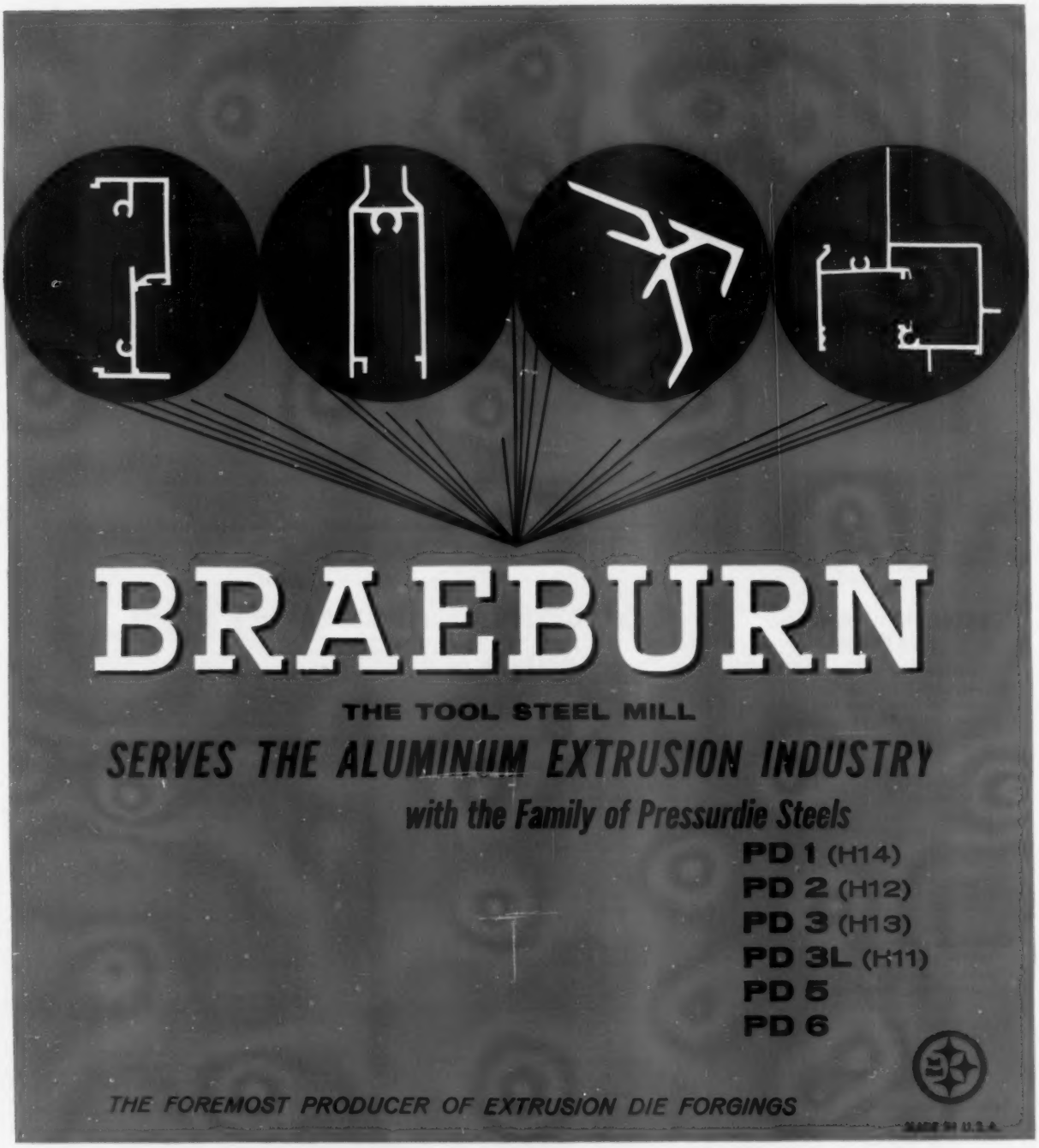
Lindberg Engineering Co.
2450 W. Hubbard St.
Chicago 12, Ill.
(billet heaters, melting furnaces, heat treating furnaces)

Loftus Engineering Corp.
One Gateway Center
Pittsburgh 22, Pa.
(billet heaters, melting furnaces, heat treating furnaces)

Loma Machine Mfg. Co., Inc.
114 E. 32nd St.
New York 16, N.Y.
(billet casters)

Lombard Corp.
639 Wick Ave.
Youngstown 1, Ohio
(billet heaters, billet casters, heat treating furnaces)

continued on page 115



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Carl Mayer Corp., The
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Cleveland 16, Ohio
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Morrison Engineering Corp.
30010 Lakeland Blvd.
Wickliffe, Ohio
(billet heaters, billet casters, melting furnaces, heat treating furnaces)

Paragon Smelting Corp.
36-08 Review Ave.
Long Island City 1, N.Y.
(melting furnaces)

Permanent Machine & Tool Co.
835 Wall St.
Florence, Ala.
(heat treating furnaces)

W. S. Rockwell Co.
200 Eliot St.
Fairfield, Conn.
(billet heaters, melting furnaces, heat treating furnaces)

Sunbeam Equipment Corp.
204 Mercer St.
Meadville, Pa.
(billet heaters, melting furnaces, heat treating furnaces)

Warwick Industrial Furnace & Engrg. Corp.
9219 Park Ave.
Franklin Park, Ill.
(billet heaters, billet casters, melting furnaces, heat treating furnaces)

EXTRUSION ACCESSORIES

American Machine & Metals, Inc.
DeBothezat Fans Div.
554 12th Ave.
East Moline, Ill.
(air quenching fans)

Baldwin-Lima-Hamilton Corp.
Industrial Equipment Div.
Philadelphia 42, Pa.
(complete extrusion installations)

Belco Industries, Inc.
9138 Belding Rd.
Belding, Mich.
(complete extrusion installations)

Clark Automation, Inc.
324 W. Main St.
Belding, Mich.
(cooling fans, cut-off saws, complete extrusion installations)

Disston Div.
H. K. Porter Co.
Tacony, Philadelphia 35, Pa.
(cut-off saw blades)

Feller Engineering Co.
1101 Empire Bldg.
Pittsburgh 22, Pa.
(complete extrusion installations)

Loma Machine Mfg. Co., Inc.
114 E. 32nd St.
New York 16, N.Y.
(billet scarfing equipment, cut-off saws)

Lombard Corp.
639 Wick Ave.
Youngstown 1, Ohio
(complete extrusion installations)

continued on next page

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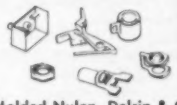
GRC tiny parts

Die Cast
ZINC ALLOY
Molded
PLASTICS

Die Cast Zinc Alloy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Coil Bobbins

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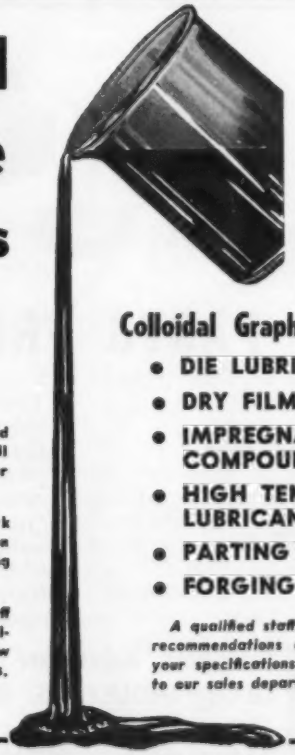

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BROOKFIELD, OHIO

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Permanent Mold Die Co., Inc.
2275 E. Nine Mile Rd.
Hazel Park, Mich.
(billet saws)

Sutton Engineering Co.
1306 First National Bank Bldg.
Pittsburgh 22, Pa.
(complete extrusion installations)

Watson-Stillman Press Div.
Farrel-Birmingham Co., Inc.
565 Blossom Rd.
Rochester 10, N.Y.
(complete extrusion installations)

Wells Mfg. Corp.
407 Jefferson St.
Three Rivers, Mich.
(cut-off saws)

Youngstown Foundry & Machine Co., The
W. Federal & Reserve Sts.
Youngstown, Ohio
(cut-off saws, complete extrusion installations)

TOOLING

Ajax Steel & Forge Co.
205 Adair St.
Detroit 7, Mich.
(containers, liners, rams)

American-International Aluminum Corp.
4851 N.W. 36th Ave.
Miami 42, Fla.
(extrusion dies)

Atlas Steels Limited
Welland, Ontario, Canada
(extrusion die blanks, dummy blocks, bolsters, containers, liners, rams)

Benda Tool & Model Works
1444 4th St.
Berkeley 10, Calif.
(dummy blocks, extrusion dies, bolsters)

Bethlehem Steel Co.
Bethlehem, Pa.
(dummy blocks, extrusion dies)

Cannon-Muskegon Corp.
2875 Lincoln St.
Muskegon, Mich.
(dummy blocks, extrusion dies)

Carpenter Steel Co., The
Front & Bern Sts.
Reading, Pa.
(extrusion die steel)

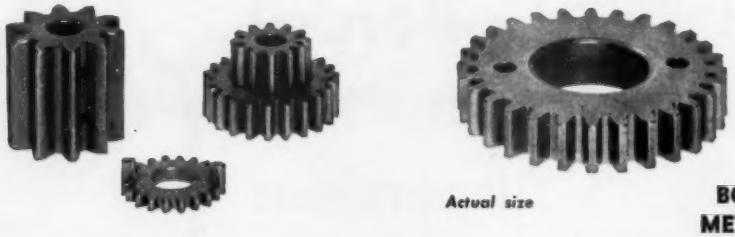
Deblin Mfg. Corp.
889 Sheffield Ave.
Brooklyn 7, N.Y.
(extrusion dies, dummy blocks, bolsters)

Doss Alloys & Industries, Inc.
22126 Ryan Rd.
Warren, Mich.
(extrusion dies, dummy blocks, bolsters)

Feller Engineering Co.
1101 Empire Bldg.
Pittsburgh 22, Pa.
(bolsters, containers)

G. R. Extrusion Die & Machine Co.
3103 Hillcroft, S. W.
Grand Rapids 8, Mich.
(extrusion dies, dummy blocks, bolsters)

D FABRICATION AND PRODUCTION PROCESSES



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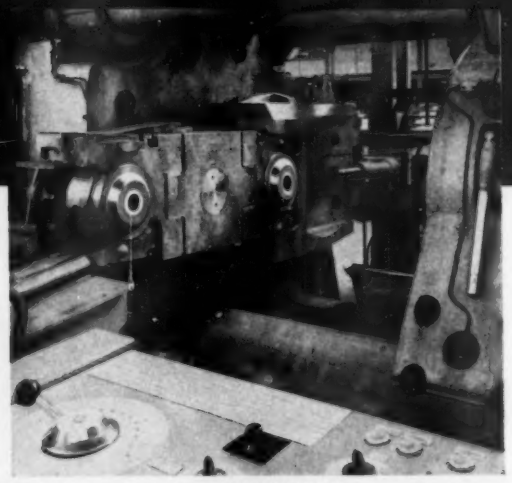

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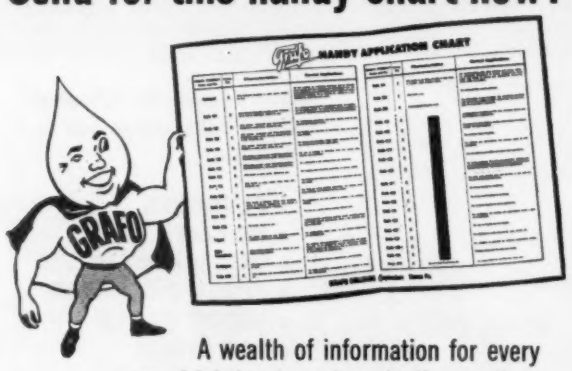

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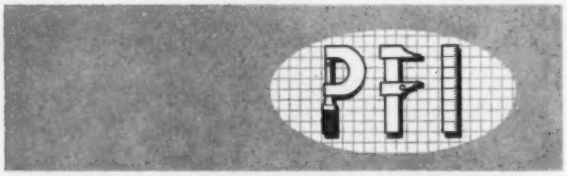

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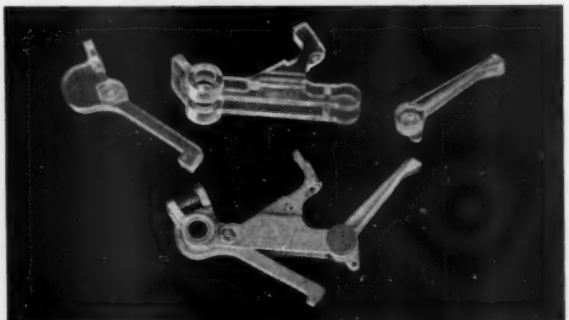

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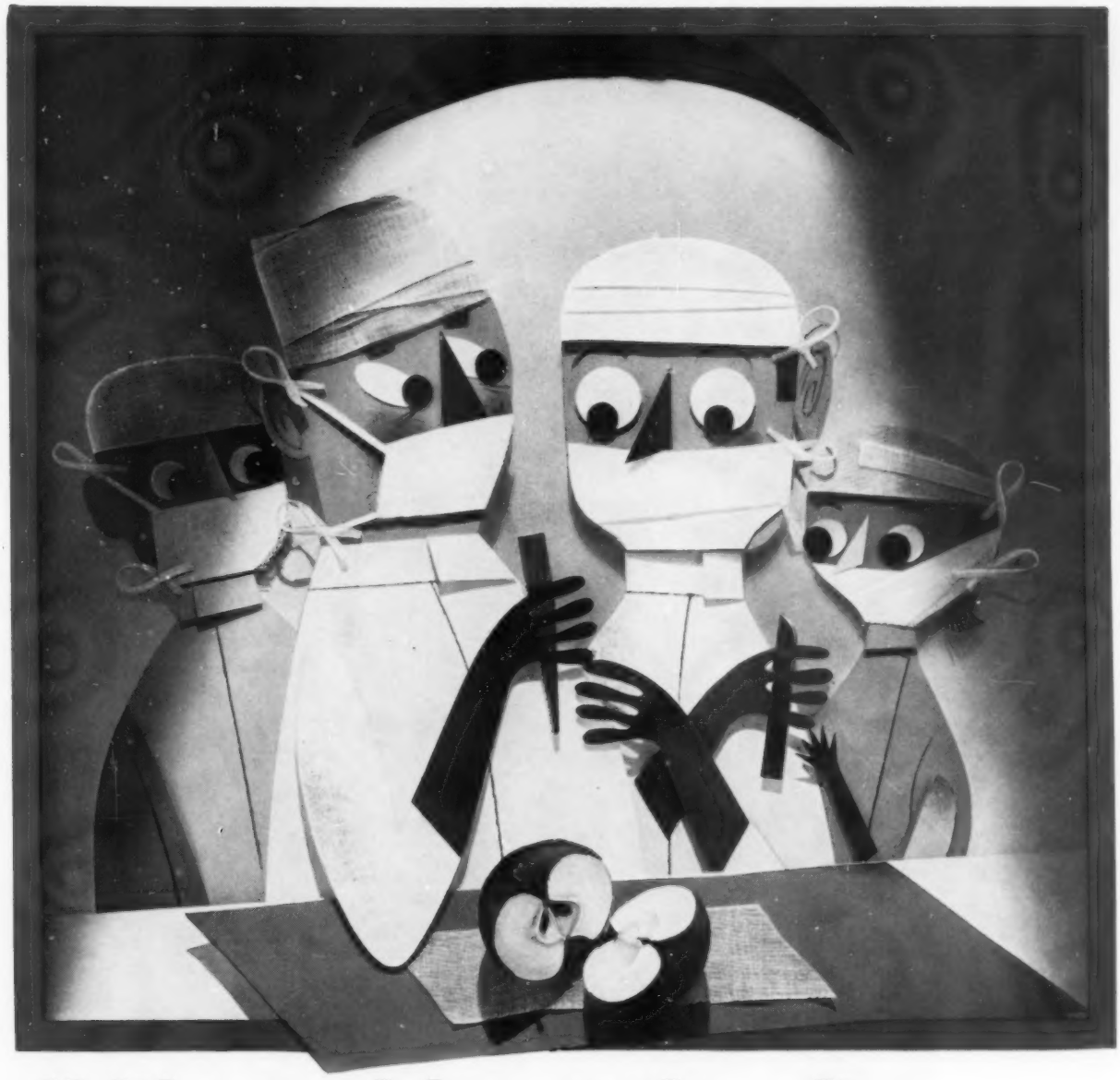

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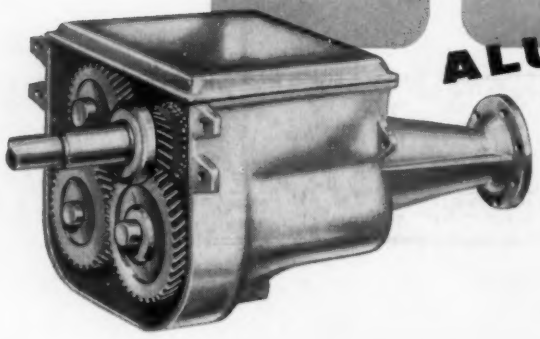

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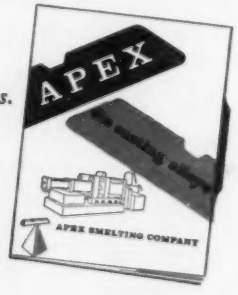

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